in the blood of yellow fever or of other diseases collected by the method described, or by any similar method, can have no great significance unless it is found to develop as a rule (not occasionally) in the blood of patients suffering from the disease in question, and is proved by comparative tests not to develop in the blood of healthy individuals, obtained at the same time and by the same method.

Tried by this test it must be admitted that certain fungi and groups of micrococci, shown in photographs taken from specimens of yellow-fever blood collected at the military hospital and preserved in culture cells, cannot reasonably be supposed to be peculiar to or to have any causal relation to this disease. While we can claim no discoveries from the microscopic examination of the blood bearing upon the etiology of yellow fever, some interesting observations have been made relating to the pathology of the blood in this disease.

It is not intended in this report to do anything more than make a brief reference to these observations, as a comparative study of the blood of other diseases will be required to give value to them, and a detailed report upon this subject is to be made at some future time. The most important observation made relates to certain granules in the white corpuscles shown in many of the photo-micrographs taken. From the manner in which these granules refract light, and for other reasons, they are believed by Dr. Sternberg to be fat, and to represent a fatty degeneration of the leucocytes.

The blood of twelve healthy individuals was examined in Havana for comparison, and in nearly every case an occasional leucocyte was found to contain a few (one or two) granules undistinguishable from those found in the blood of yellow fever; but this was the rare exception; while in severe cases of yellow fever the granules were abundant, and nearly every white corpuscle contained some of them.

VIII.

EXPERIMENTS UPON ANIMALS.

It has been commonly reported, and is asserted by several writers of acknowledged ability, that during the prevalence of yellow fever certain of the inferior animals exhibit symptoms of sickness which are attributable to the influence of the yellow-fever poison.

(Vide Barton, cause and prevention of yellow fever, third edition, pp. 52-55; Feraud, de la fiévre jaune à la Martinique, p. 271; La Roche on yellow fever, volume 2, pp. 316–318; Blair, Yellow fever epidemic of British Guiana, third edition, p. 63.)

In view of these reports, the Commission was instructed as follows: "It is obvious that if it be found possible to produce some specific symptoms in some one of the lower animals by exposing such animals in localities known to be capable of producing the disease in man, and thus to establish a physiological test of the presence of the cause of the disease, we may even hope to be able to determine the nature of and the natural history of this cause, although prolonged investigation may be necessary to effect it."

The Commission has endeavored to carry out the views of the Board of Health in this direction, but in consequence of the limited time at its disposal, the want of a suitable place to keep the larger animals, and the amount of work in other directions expected from it, it has been found impossible to make an exhaustive experimental investigation. Enough has been done, however, to make it appear highly probable that the sickness and mortality reported among animals during the prevalence of yellow fever epidemics has been improperly ascribed to the influence of the yellow-fever poison. It is well known that many of the inferior animals suffer from epidemic diseases peculiar to their several species, and this is especially the case in southern latitudes. We know of no reason why such epidemics should not occur coincidently with yellow fever in man, and it is not surprising that many people unaccustomed to close observation should attribute the sickness in man and in the animals affected to the same cause. In advance of any experiments designed to test the truth of such a deduction, it seemed quite improbable, from the fact that the supposed effect only results exceptionally, if at all, while domestic animals are frequently exposed in large numbers, in localities visited by severe epidemics of yellow fever, without exhibiting any symptoms of sickness. This fact is vouched for by many competent observers and is verified by the personal experience of two members of this commission.

Nevertheless, in view of the reports referred to, of the great importance in the prosecution of the investigation of a test of the presence of the poison, and of the possibility that by close observation and the use of the clinical thermometer some symptoms heretofore overlooked might be discovered sufficient to serve as such a test, it was evidently imperative that experiments should be tried in this direction. Arrangements were accordingly made before leaving New York for a supply of animals as required, and on the 24th of July the following were received, per steamer Niagara, viz: Four dogs, two cats, six rabbits, six guinea-pigs, one monkey, six chickens, twelve pigeons, and two geese. Subsequently (August 30) six more dogs were received.

All of these animals were carefully observed, and various experiments were tried for the purpose of testing their susceptibility to the influence of the yellow-fever poison. The details of these experiments are given in a special report to the National Board of Health, dated October 15. It is not deemed necessary to give these details in the present report, but the general statement may be made that the results were negative. No symptoms were produced in any of the animals experimented upon which can fairly be attributed to the influence of the yellow-fever poison.

The clinical thermometer was constantly used for the purpose of recognizing any slight febrile movement which might possibly occur, and the blood was examined microscopically from time to time. As the experiments made gave no promise of positive results, the Commission did not feel justified in giving more time to this portion of the investigation. It is, however, of the opinion that the reports heretofore referred to and the importance of a physiological test of the presence of the poison would justify the National Board of Health in pursuing this inquiry in future, especially with such animals as this Commission has not experimented upon. A few experiments are here given as examples of those made:

Experiment No. 1.—On the morning of July 28, four days after arrival in Havana, the following animals were exposed on board the infected brig *John Welch, jr.*, viz: two dogs, two cats, one monkey, two rabbits, three Guinea pigs, two geese, three chickens. The time of exposure was forty-eight hours, at the expiration of which time the animals (in cages) were brought back to the laboratory. The *Welch* was a very foul ship, and was loaded with molasses. During the time the animals remained on board six of her crew (all) were down with yellow fever. After bringing the animals back to the laboratory the temperature of each was carefully taken, and daily observations were continued for some time after. No symptoms of sickness presented themselves except in the case of one dog. This animal suffered a sharp attack of fever, but it is believed that the case was one of a disease common to imported dogs in Cuba known as *romadizo*, a disease the clinical history of which is very different from that of yellow fever. (See special report to National Board of Health, dated October 15, for full history of this case.)

Experiment No. 4.—Injected yellow-fever blood, 1½ drachms, of first day into femoral vein of dog No. 3. Blood obtained by cupping from patient in civil hospital and mixed with a small quantity of soda bicarb., to prevent coagulation. *Result*, entirely negative.

Experiment No. 10.—One-half of a blanket from a yellow-fever patient's bed was placed in the cage with dog No. 4 and left there for several days. *No result.*

Experiment No. 11.—Dog No. 5 was allowed no water for two days, except a supply in which the other half of this blanket (Experiment No. 10) had been washed. *No result.*

Experiment No. 14.—Injected cocoanut water, drachm, containing numerous actively moving bacteria (b. termo) into external saphenous vein of dog No. 7. This fluid had been inoculated two weeks previously with yellow-fever blood of the first day, which was sent from the civil hospital (without precautions to exclude atmospheric germs) and had been kept since in a beaker covered with glass plate and bell jar—Lister's apparatus. The blood of this dog was carefully examined five hours after the operation, and again on the following morning, Spencer's one-tenth inch objective used in examination. No bacteria were seen and no appreciable symptoms resulted from the injection.

IX.

CULTURE EXPERIMENTS.

If the essential cause of yellow fever exists in infected localities as a living germ or organism, capable, under favorable conditions, of indefinite multiplication, a hypothesis which explains the phenomena of epidemics better than any other, and which has much in its favor, then one of the most promising methods of investigation would seem to be by experiments designed to promote the increase of the hypothetical germ in culture cells, bottles, &c., for the purpose of microscopic examination and physiological experiment.

In Havana various culture experiments were made, of which only a brief account will be given in this preliminary report. Many specimens of yellow-fever blood, preserved in culture cells, were kept under daily observation for from three to ten days from the time of collection. In some of these, hyphomycetous fungi, and in others spherical bacteria, were developed, but in a majority nothing of the kind was observed, and there is good reason to believe that the exceptional appearance of these organisms was due to inoculation of the drop of blood by atmospheric germs during the short time occupied in collecting and mounting the specimen. (*See* report on examination of the blood.) In these culture experiments, and all others tried, it was assumed that the summer temperature of Havana is favorable for the development of the yellow-fever germ, and no artificial heat was used. Organic fluids, such as urine, black vomit, and the fluid from the interior of unripe cocoanuts, exposed in the laboratory, very soon became filled with a variety of vegetable organisms, bacteria, torulæ, vibriones, and other fungi, such as are found under similar circumstances in all parts of the world. Most of these were well-known and common forms; some may have been peculiar to the latitude or even to localities infected with yellow fever, but to decide this question would require a more precise knowledge in regard to these low forms of vegetable life than was possessed by any member of the Commission, or, indeed, than is likely to be found even among those who have devoted the most attention to this branch of study, which is acknowledged by all to be yet in its infancy.

Photo-micrographs were made of some of these forms, and it is suggested that photographic representations of all forms found in southern parts of the United States at a time when yellow fever does not prevail should be made in advance of the next epidemic, so that any unusual form presenting itself then may receive the special attention of future investigations.

The transparent liquid from the interior of an unripe cocoanut, called in Cuba "aqua coco" and in the United States cocoanut milk, was found to be well adapted for culture experiments Drawn from the nut with proper precautions into a Florence flask provided with a Tyndall filter, it was preserved in the laboratory for two months transparent and free from bacteria. But when exposed to unfiltered air it very quickly became filled with bacteria, torulæ, and various fungi. Some of these are shown in the photo-micrographs taken in Havana. The following culture experiments are given in detail, as

it is believed that the method is worthy of adoption by future observers:

Experiment.—Placed in a wide-mouthed quart bottle, a little sea water and a considerable quantity of sea-weed from the beach, taken from a locality supposed to be infected. Two glass tubes passed through the cork of this bottle for the purpose of allowing the air contained in it to be aspirated through a small quantity of glycerine or other liquid for microscopic examination. In a second bottle, having a capacity of two quarts, was placed a fragment of blanket from the bed of a yellow-fever patient and a double handful of rotting sawdust. The cork was also provided with tubes for aspiration of the contained air. Both of these bottles were placed outside of the laboratory, where they were exposed to the sun during the day and from time to time the inclosed air was aspirated through a drop of glycerine jelly. Upon microscopic examination the specimens from both bottles were found to contain numerous spores of penicillium and probably of other fungi, vegetable *débris*, epithelial cells from bottle No. 2, and a microscopic fungus, which being unknown to the observer and occurring in considerable abundance attracted especial attention.

It was found that the most satisfactory way of collecting this fungus was by suspending in the bottle by a string a small glass beaker, in the bottom of which was placed a thin glass cover. The cork being replaced the bottle was left undisturbed for two days. The beaker was then removed and the thin cover was inverted over a circle of white zinc cement turned upon an ordinary glass slip. The fungus could then be studied by the microscope and was best seen by reflected light. No attempts are made to describe this fungus or other organisms observed in the culture experiments made, as there has been as yet no opportunity to submit the specimens obtained and the photographs made to the critical examination of an expert mycologist.

X.—EXAMINATION OF WATER OF HARBOR.

The prevalence of yellow fever in Havana as an endemic disease has been supposed by some to be due to the narrow entrance and small size of its harbor, and to the fact that the drainage and sewerage of a large portion of the city is poured into this land-locked basin, which has no fresh water stream of any size flowing into it, and consequently no means of purification except by deposition of suspended matters and by the tides, which here do not rise more than twenty-four inches. To remedy this supposed source of disease expensive engineering schemes have been proposed, having for their object the admission of a sufficient volume of water, through canals from the gulf or from the Almandarez River, to effect the purification of the water of the harbor by means of a constant current through it. Whether these schemes are practicable or not is a question for engineers to decide. Whether they would be effectual in accomplishing the desired result is a question for the consideration of sanitarians in advance of any expensive engineering undertaking. With a view to furnishing data upon which to found an opinion in regard to this matter, numerous samples of water from the harbor were examined, with the following general result:

When there has been no rain for some time the water of the harbor is tolerably transparent, and has the same specific gravity as the water of the gulf just outside, viz: 1.020 at 85° Fah. Water collected from near the shore in front of the San Carlos hotel, during the dry season, was found to be transparent and odorless, and to have a specific gravity of 1.022 at 84° Fah. It deposited on standing a very slight sediment, containing vegetable *débris* and a few animalculæ.

This water, exposed in the laboratory in a wide-mouthed bottle for two weeks, did not undergo any putrefactive change recognizable by the sense of smell or by a change in transparency. After a heavy fall of rain, however, the water became muddy in appearance, seen in mass, and the specific gravity of samples collected near the shore fell to 1016 or even to 1005 in the vicinity of sewers and places where the drainage from the streets made a considerable stream of fresh water. These specimens of low specific gravity contained considerable amorphous mineral matter, vegetable debris, and infusoria of various forms, including spirilla, vibriones and rod-bacteria. These bacteria did not exhibit active movements, and doubtless had been washed into the harbor from the streets and sewers. Probably, being fresh-water species, their reproductive power, if not their vitality, was soon destroyed by the salt water. In the vicinity of the fish market, and elsewhere, where sewers discharge into the harbor, the water has an offensive odor, and evidently contains much putrefying organic material. There is reason to believe that the atmosphere in the vicinity of these places is unwholesome and that the yellow-fever poison lurks about such insanitary localities. But that the water of the harbor generally is contaminated with this poison seems doubtful. Ships which anchor some distance from the shore, and which discharge and receive cargo at their anchorage, certainly do not suffer to the same extent as those which come to the wharves; and where stringent regulations are enforced to prevent the crews from going ashore, they often escape entirely.

There is reason to believe, therefore, that the putrefying organic matter washed into the harbor from the streets of the city and margins of the basin generally is so diluted and changed by the salt water that a short distance from the shore it loses its potency for mischief. Probably no inflow of water through a canal would prevent entirely the insanitary condition of limited areas in the immediate vicinity of the discharge of sewers. And it seems to this Commission that money and engineering skill would be more profitably expended in paving the unpaved streets; in constructing stone wharves in place of the wooden ones which now serve as traps for all kinds of filth, and probably as a permanent abiding place for the yellow-fever poison; in making new sewers where needed; and, if practicable, in frequently flushing the sewers and washing the streets during the dry season.

XII.—EXAMINATION OF THE AIR.

That yellow fever is usually contracted by respiring, in infected localities, a poisoned atmosphere seems beyond question; and many things in the behavior of the specific poison of the disease, such as its portability, the tenacity with which it clings to surfaces, clothing, &c., seem to prove that it is particulate. There is, therefore, reason to hope that it may be eventually demonstrated by the microscope. In Havana various methods were resorted to for the purpose of collecting the suspended matters in the atmosphere for microscopic examination. At first the method by aspiration was adopted, and ninety permanent preparations were made from eighteen different localities by passing a considerable quantity of air through a few drops of glycerine jelly or acetate of potash solution and mounting these liquids in shallow cells of white-zinc cement. These preparations show many things very satisfactorily, but for immediate examination the simpler method of exposing a clean glass slip for forty-eight hours in a place protected from currents of air was found to give more interesting and varied results.

Common experience proves how quickly dust accumulates upon exposed surfaces in dwellings, hospitals, &c., and Professor Tyndall has shown that in a closed apartment where there is no disturbance of the atmosphere all the suspended matters soon settle to the floor of the chamber, leaving the air as free from particulate contents as if it had been filtered through a cotton filter. This is proved by the fact that a beam of light passed through the chamber, not meeting with reflecting surfaces, does not have a luminous path.

Upon the glass slips exposed in Havana in the yellow-fever wards of hospitals, in the laboratory of the Commission, and on infected vessels, the dust deposited was found to contain a variety of vegetable organisms, and numerous extremely minute crystals, in addition to the amorphous mineral and vegetable matters, epithelial cells, &c., which make up the greater part of the dust found everywhere.

Attention was particularly attracted to certain slender glistening acicular crystals radiating from little opaque masses, which were especially abundant in the yellow-fever wards and in the soiled-linen room of the military hospital. Subsequent observations in the United States have added to the interest which these striking objects aroused when first seen. Soon after the return of the Commission the National Board of Health had a session in Washington, and several of the members on returning to their homes took with them some watch-glasses arranged in little boxes, so that they could be conveniently packed and sent by mail. These watch-glasses were exposed in various places, and returned to Washington for microscopic examination of the dust deposited upon them. They were received in good order, and had adhering to the concave surface of each glass a deposit of dust more or less abundant, according to the place of exposure. Seven boxes, each containing two glasses, were received from infected localities, viz, two from Morgan City, Louisiana, four from Centreville, Louisiana, and one from Bayou Boeuf.

Of these, six pairs of glasses had been exposed in the rooms occupied by yellow-fever patients, and one pair outdoors, in an infected locality. All of these glasses were found to have adhering to them a considerable number of radiating acicular crystals, exactly similar in appearance to those discovered in Havana. Eight boxes were also received from places supposed to be not infected, viz, four from Bellevue Hospital, New York, and four from Charity Hospital, New Orleans. The watch-glasses inclosed in these boxes had been exposed in the wards of these hospitals and in the dead-house and soiled-linen room of Charity Hospital. All were well covered with a deposit of dust, and none of those from New York presented any appearance of crystals. The glasses from New Orleans, however, had a very few of the acicular crystals described and a considerable number of prismatic crystals, exactly resembling crystals found in Havana upon glass slips exposed in the laboratory and in the Military Hospital. Whether these and the prismatic crystals are different substances or different forms of the same substance, whether they, one or both, bear a causal relation to yellow fever, whether they are present in the atmosphere in greater abundance during the prevalence of yellow fever without being the true poison of the disease, or whether they are entirely independent of this disease, are questions to be determined by future investigations. But the facts already presented, and the additional fact that no description or figure of anything like these acicular crystals is to be found in the amply illustrated reports of Maddox, Cunningham, Miquel, and others, make it imperative that the investigation be pursued until these questions are answered. Crystals deposited from the atmosphere are mentioned both by Cunningham and Miquel, and prismatic crystals are figured by the latter writer, which may be identical with those of similar form found in Havana. But the elongated, flexible, acicular crystals shown in photo-micrograph No. 204 from Havana and No. 1 from Morgan City are so peculiar and striking that these careful observers could scarcely have failed to describe and figure them if they had found them during their researches. At first it was a matter of doubt whether these slender, glistening filaments were

SUPPLEMENT

National Board of Health Bulletin.

THE HAVANA COMMISSION.

Preliminary report of the Havana Yellow-Fever Commission of the National Board of Health, submitted November 18, 1879, by S. E. Chaillé, M. D., chairman, and G. M. Sternberg, M. D., U. S. A., secretary.

This report is submitted in accordance with the following resolution of the commission adopted September 25, 1879, and subsequently approved by the National Board of Health:

"*Resolved*, That, subject to the approval of the National Board of Health, the chairman and secretary be appointed a committee to draw up a concise preliminary report, stating the general results accomplished by the commission; also, that each member make a detailed report of his own work in the investigation; which special reports shall be made with such detail and labor as may be consistent with the views of the National Board of Health and with the opportunities of the several members for the further study of the subjects which have especially engaged their attention in Havana."

The memorandum of instructions for the commission appointed by the National Board of Health to visit the island of Cuba for the purpose of investigating certain points connected with the prevalence of yellow fever in that island, states that in organizing the commission the National Board has more especially in view the following desiderata:

First. To ascertain the actual sanitary condition of the principal ports in Cuba from which shipments are made to the United States, more especially the ports of Havana and Matanzas, to determine how these sanitary conditions can best be made satisfactory, and more especially as to what can and should be done to prevent the introduction of the cause of yellow fever into the shipping of these ports.

Second. To increase existing knowledge as to the pathology of yellow fever, that is, as to the changes and results which it produces in the human body.

Third. To obtain as much information as possible with regard to the so-called endemicity of yellow fever in Cuba, and the conditions which may be supposed to determine such endemicity. This of course involves a careful examination of neighboring localities where the disease does not appear to have its cause permanently localized.

The three points above referred to are believed to be those which will most certainly yield results to scientific investigation, and which therefore should receive the special attention of the commission.

But in addition to these the National Board of Health desires that the commission shall consider certain problems relating to this disease; problems which may be entirely insoluble, but which nevertheless are of such importance that an effort should be made to decide whether the National Board of Health will be justified in undertaking the labor and expense which will probably be required to obtain anything like a complete solution of them, if such solution is at all possible. These problems relate to the nature and natural history of the cause of yellow fever, and the most important preliminary investigation on this point is to ascertain some means of recognizing the presence of the immediate cause of yellow fever other than the production of the disease in man. These means might, for example, be the production of some special phenomena in some of the lower animals, or it might be the finding of a special microdeme in all yellow-fever cases, and no others. It is obvious that if it is found possible to produce some specific symptoms in some one of the lower animals by exposing such animals in localities known to be capable of producing the disease in man, and thus establish a physiological test of the presence of the cause of the disease, we may even hope to be able to determine the nature and the natural history of this cause, although prolonged investigation may be necessary to effect it.

With the time and means which the National Board of Health can at present put at the disposal of the commission no complete investigation is possible. All that is hoped for is that the commission will be able to obtain some grounds for a positive opinion as to whether it is probable that such an investigation would put us in possession of the test referred to.

It is not proposed to go into details as to the modes of attacking this problem; but one thing is insisted on, and that is that as far as possible what is done shall be so done and so recorded that it need not be done again hereafter.

It is expected that the commission will organize itself and devise for itself the methods and order of carrying out the work above indicated. It is desired that the report to be furnished the board shall be made by the members jointly as a commission. In other words, it is expected that each member will be careful to verify the results obtained by the other members, or to note distinctly the absence of such verification.

The following extract from letter of June 26, 1879, contains further instructions:

"It is the wish of the National Board of Health that the work above specified under several distinct heads should engage the earnest attention of all members of the commission until such work is completed, to the exclusion of all other lines of investigation, such, for example, as the clinical observation and record of cases."

The following resolutions of the National Board of Health, dated June, were received:

"*Resolved*, That Dr. G. M. Sternberg, Dr. S. E. Chaillé, T. S. Hardee, C. E. and Dr. J. Guiteras, appointed to make investigations at Havana, Matanzas, and other places in Cuba, be, and are hereby, directed to complete their organization under the title of 'The Havana Yellow-Fever Commission of the National Board of Health of the United States,' by the election of a permanent chairman, and secretary, who shall be disbursing officer of the Commission, and by the adoption of rules governing the Commission.

"*Resolved*, That a quorum to transact business shall be three, and its action shall be binding upon individual members.

"*Resolved*, That all official communications to the National Board of Health from the commission shall be signed by the president and secretary.

"*Resolved*, That when the commission has effected a permanent organization it shall transmit to the National Board of Health its plan of organization, including all its rules, and thereafter shall regularly transmit weekly reports of progress."

In compliance with the foregoing instructions, received June 20, "The Havana Yellow Fever Commission of the National Board of Health of the United States" was organized by the election of Dr. S. E. Chaillé as chairman, and Dr. G. M. Sternberg as secretary, and by-laws were adopted for the government of the Commission.

At a meeting of the Commission held in Washington, D. C., on the 23d of June, the following resolutions were adopted:

"*Resolved*, That Dr. Chaillé and Colonel Hardee be appointed a committee to conduct that portion of the investigation indicated in memorandum of instructions, No. 1, under headings "First" and "Third," and Drs. Sternberg and Guiteras a committee to conduct that portion of the investigation indicated in the same memorandum under heading "Second," and under additional instructions following "Third," and relating chiefly to the nature and natural history of the yellow-fever poison.

"*Resolved*, That each committee procure before sailing such apparatus and appliances as will be required in that portion of the investigation under its immediate direction."

The National Board of Health had some time previously, after consultation with Surgeon J. J. Woodward, U. S. A., ordered the following microscopic apparatus, viz: One army stand of Zentmyer, (Philadelphia;) one large stand of Powell & Leland, (London,) with eye-pieces, achromatic condenser, &c., and the following objectives: 4-inch, 2-inch, 1-inch, and $\frac{1}{4}$-inch, dry, of Powell & Leland; $\frac{1}{8}$-inch and $\frac{1}{10}$-inch, glycerine immersion, of Spencer & Sons, (Geneva, N. Y.;) $\frac{1}{18}$-inch, oil immersion, of Zeiss, (Jena, Germany,) also, a heliostat of Keith's pattern, by Kübel, (Washington, D. C.)

Unfortunately the Powell & Leland apparatus and the Spencer objectives were not delivered until some time after the departure of the Commission, and not received in Havana until the 28th of August, when but little more than a month remained of the time allotted to the investigation. An ample supply of apparatus and accessories for microscopical and chemical work, and a full stock of photographic material, was also procured in advance of the time of sailing, and, by the liberal policy of the Board of Health, the Commission has been fully supplied with everything necessary for carrying out the instructions given it.

These instructions are, however, so comprehensive and the time allotted to the investigation has been so short that the members of the Commission would fear that they have fallen short of the expectations of the board, notwithstanding the fact that they have given their best efforts to the accomplishment of the responsible duties assigned them, were it not that the following paragraph occurs in the memorandum of instructions under which they have acted: "With the time and means which the National Board of Health can at present put at the disposal of the Commission no complete investigation is possible," &c.

The three medical members of the Commission, with Mr. Rudolph Matas, clerk, and Mr. Henry Mancel, photographer, sailed from New

York, per steamship *City of Washington*, on the 3d of July, and arrived in Havana on the evening of the 7th. Colonel Hardee joined the Commission in Havana on the 18th of August and returned to New Orleans September 20.

Immediately after arriving in Havana the Commission established its office and laboratory in the upper story of the San Carlos Hotel, where very suitable rooms, overlooking the harbor, and conveniently located with reference to the hospitals, were found at a moderate rental. The Commission was also influenced in selecting this hotel as its headquarters by the fact that Mr. H. C. Hall, United States consul-general, and Dr. Daniel Burgess, an American physician practicing in Cuba, (since appointed United States sanitary inspector of the port,) resided here. To these gentlemen and to Mr. A. H. Taylor, an American civil engineer located in Havana, the Commission is indebted for innumerable favors. All of these gentlemen have manifested a lively interest in the investigation, and from their long residence in Cuba and intimate knowledge of the city of Havana, its harbor, and inhabitants, they have been able to render constant and valuable assistance. Soon after its arrival in Havana the Commission, accompanied by Consul-General Hall, made an official call upon the Captain-General, Don Ramon Blanco, Marquis of Peña Plata. At this interview the Commission learned with pleasure that instructions had already been received from the "home government" to extend to it all necessary facilities for prosecuting its work. Both on this occasion and by his subsequent acts the Captain-General evinced a willing zeal in carrying out his instructions which could only have come from a personal interest in and appreciation of the work in which the Commission was engaged.

Shortly after this interview the Captain-General appointed an Auxiliary Commission, constituted as follows:

President—Dr. Marcelina Astray de Canada, Sub-Inspector, first rank, of the Naval Board of Health, Honorary Chief of Civil Administration, Member of the Superior Board of Health of the Island, &c.

Members—Dr. Felipe F. Rodriguez, Professor of Anatomy, Member of the Havana Academy of the Medical, Physical, and Natural Sciences, &c.; Dr. Vincente Luis Ferrer, Secretary of the Superior Board of Health of the Island, &c.; Dr. Vincente Benitez Valdez, Member of the Havana Academy, Member of the Superior Board of Health, &c.; Dr. Joaquin Garcia Lebredo, Member and founder of the Havana Academy, Correspondent of the Royal Academy of Medicine of Madrid, &c.; Dr. Antonio Pardinas, Sub-Inspector of the Military Health Department, Director of the Military Hospital, &c.; Dr. Casimiro Rome, Sub-Inspector, first class, Brevet Chief of the Military Board of Health, Staff Officer of the Captain-General, &c.; Dr. Raphael Fleitas, Director of the Military Health Park, Sub-Inspector, of second class, Director of the Hygienic Hospital; Dr. Charles Finlay, Member of the Academy of Medical, Physical, and Natural Sciences; Dr. Serafin Gallardo, Professor of Clinical Medicine in the University of Havana; Dr. Francisco Zayas; Dr. Emiliano Nunez de Villavicencia, Member of the Academy, Director of the Civil Hospital of San Felipe y Santiago, and Secretary of the Spanish Commission for the Study of Yellow Fever.

The object in appointing this commission was that through it the United States Commission might obtain promptly such information and assistance as was required, and also that there might be a permanent organization in Havana to continue the study of yellow fever after the departure of this Commission. Much valuable information has been received through the Spanish commission, and to several of its members we are especially indebted. To the president, Dr. Canada, the director of the military hospitals, Dr. Pardenas, the foreign corresponding secretary of the "Acdemia," Dr. Charles Finlay, and to Dr. Felipe Rodriguez we are under many obligations.

For the purpose of securing as soon as possible information as to the sanitary condition of the principal seaports and inland towns of Cuba, a circular was issued by the Commission soon after its arrival, embodying the instructions received from the National Board of Health, and propounding questions based upon them. The response to this circular has been the receipt of so large a number of valuable reports from the Spanish Commission, from United States consuls, and from eminent physicians, that your Commission has in its possession more extensive and instructive data referring to yellow fever in Cuba than have ever before been collected.

The Commission held weekly meetings while in Cuba, and in compliance with its instructions made a weekly report to the National Board of Health, giving a brief account of the progress of the investigation, and reporting such facts and observations as seemed of greatest importance.

The last formal meeting of the Commission in Cuba was held September 25. At this meeting the following resolutions were adopted:

"*Resolved*, That, subject to the approval of the National Board of Health, the chairman and secretary be appointed a committee to draw up a concise preliminary report, stating the general results accomplished by the commission; also, that each member make a detailed report of his own work in the investigation, which special reports shall be made with such detail and labor as may be consistent with the views of the National Board of Health, and with the opportunities of the several members for the further study of the subjects which have especially engaged their attention in Havana."

In compliance with this resolution, which has received the approval of the National Board of Health, it is the intention of the committee in this preliminary report to record only the most important facts obtained and the general results of the investigation, leaving details and the discussion of unsettled problems to the individual reports of members, to be submitted hereafter.

In addition to acknowledgments already made, the Commission desires to exprsss its obligations to the following gentlemen:

Col. R. Ceréro, of the Spanish army, commander of the engineers of the Plaza; Rev. Father Vines, director of the meteorological observatory of the College of Belen; Dr. José R. de Armona, Marianao; Dr. Juan Antonio Beltran, Marianao; Dr. E. A. Calves, Matanzas; Dr. A. G. Del Valle, Guanabacoa; Dr. A. Cuervo, Sancti Spiritus; Dr. José Forus, Marianao; Dr. Esteban Navea, San José de las Lajas; Dr. A. W. Reyes, Guanabacoa; Dr. P. Selsis, Havana; Dr. Nicolas de la Peña, medical director of hospitals, Sagua la Grande; Messrs. Ariza & Herrera, city architects, Havana.

The clerk of the commission, Mr. Rudolph Matas, and the photographer, Mr. Henry Mancel, have performed their duties in a most zealous and satisfactory manner. Dr. Abraham Morojan, of Cuba, a recent graduate of the University of Pennsylvania, rendered valuable services as interpreter and assistant in post-mortem and other work.

REPORT.

The first and third articles of the official instructions of the National Board of Health to the Havana yellow fever commission required it to investigate the following six among other subjects, and these six will be considered in the following order:

First. The principal ports of Cuba from which shipments are made to the United States.

Second. The endemicity of yellow fever in Cuba.

Third. The causation of this endemicity.

Fourth. The actual sanitary condition of Havana, Matanzas, and other Cuban ports.

Fifth. The means by which the sanitary condition of Havana, Matanzas, and other Cuban ports can be best made satisfactory.

Sixth. What can and should be done to prevent the introduction of the cause of yellow fever into the shipping at Cuban ports.

I.

THE PRINCIPAL PORTS OF CUBA FROM WHICH SHIPMENTS ARE MADE TO THE UNITED STATES.

Cuba, situated less than one hundred miles from the southern extremity of Florida, with the Tropic of Cancer between them, varies in width from 20 to 135 miles, having an average breadth of 52 miles, extends in length 783 miles, and, with its small adjacent and dependent islands, occupying 47,278 square miles, is a little larger than the State of New York. Its extensive coast line of 2,200 miles is noted for the number and excellence of its harbors.

Cuba has more than 200 ports. On the northern coast there are not less than eleven of these rated as of the first, and twenty-two of the second class; and on the southern coast, five of the first and six of the second class. Of these forty-four principal ports, only fifteen are "ports of entry" from which shipments are made to foreign countries, and hence only these fifteen are of any interest in connection with the infection of vessels.

Of the fifteen "ports of entry," eight are on the northern and seven on the southern coast. Those on the northern coast, passing from west to east, are Havana, Matanzas, Cardenas, Sagua La Grande or Sagua, Caibarien (the seaport of Remedios), Nuevitas (a seaport of Puerto Principe), Gibara or Jibara (a seaport of Holguin), and Baracoa, which was the first European settlement (1512) in Cuba, and is the present principal port of the fruit trade.

The seven "ports of entry" on the southern coast, passing from east to west, are Guantanamo, Santiago de Cuba or Cuba, Manzanillo, Santa Cruz, Zaza or Sasa or Tunas de Zaza, Trinidad, and Cienfuegos. These fifteen "ports of entry" are important to the commercial interests of the United States in the following order, beginning with the most and ending with the least important: Havana, Matanzas, Cardenas, Sagua la Grande, Cienfuegos, Baracoa, Caibarien, Guantanamo, Trinidad, Santiago de Cuba, Manzanillo, Nuevitas, Gibara, Laza, and Santa Cruz. From the five ports first mentioned are cleared three-fourths of all the vessels which sail from Cuba to the United States, but for reasons which will subsequently appear the port of Havana alone is of greater importance to the sanitarian than all the others.

The following table will serve to illustrate the relative commercial importance of these ports. It requires a brief preliminary explanation. While the table refers solely to American vessels, it must not be forgotten that about one-third of the trade from Cuba to the United States is carried on in foreign vessels, so that the statistical facts given refer to only about two-thirds of this trade. Further, these facts are perfect for only ten of the fifteen ports, for the reasons that the United States consuls at Guantanamo, Zaza, and Manzanillo* failed to forward the necessary reports, that at Gibara this country has no consul, and that Santa Cruz not only has no consul but also is of so little consequence that during the past year no

* The report from Manzanillo has been received, but subsequent to the compilation of the table.

American vessel has either arrived at or sailed from it; therefore Santa Cruz is omitted:

TABLE NO. 1.*—*Statement of the number of American vessels, their average tonnage, and the number of their crews, sailing from the ports of Cuba to the United States during the year ending December* 31, 1878.

Ports.	Number of vessels.	Average tonnage.	Number of crew.
1. Havana	503*	653.8	10,505
2. Matanzas	313	399.5	2,615
3. Cardenas	291	334.9	2,358
4. Sagua la Grande	146	341.4	973
5. Cienfuegos	152	427.3	1,581
6. Baracoa	130	118.7	832
7. Caibarien	60	366.9	514
8. Trinidad	28	341.5	221
9. Santiago de Cuba	22	488.9	177
10. Nuevitas	3	327.8	21
Totals	1,648	†	19,797
11. Guantanamo	30 to 40	....	....
12. Manzanillo	14 to 20	....	....
13. Gibara	5 to 10	....	....
14. Zaza	3 to 7	....	....
Grand totals	1,700 to 1,725	....	20,200†

*Tables Nos. 1, 3, and 4 have been compiled from reports kindly furnished through Mr. H. C. Hall, United States consul-general at Havana.

A Cuban report for the 10 years, 1868–'77, shows that the total number of vessels of all nations which entered the port of Havana varied during said ten years from 1,650 to 2,194 per annum, the annual average being 1,803; and that of these, 717 to 944 were American, the annual average being 800. It is to be remembered that many American vessels sail from Havana to other ports besides to those of the United States.

† Average number of vessels clearing annually.

Similar data for other years and to July, 1879, indicate that this table for 1878 represents a fair annual average of recent years; and, if the figures reported for American shipping be increased one-third for the foreign shipping,* it appears that there annually pass from Cuba to the United States not less than twenty-five hundred vessels, carrying some thirty thousand sailors. What number of persons in addition to these thirty thousand sailors pass annually to the United States from Cuba is not known, but it was found that from four thousand to six thousand passengers travel every year between the United States and the single port of Havana.

While these facts seem to reply sufficiently not only to the question, "What are the principal ports of Cuba?" but also to the question, "What is the amount of intercourse with and relative importance of these ports?" it has been deemed essential, in connection with present or future quarantine and other sanitary regulations, to investigate three other questions subordinate to the main one. These are, 1. What is the amount of intercourse between each of the various ports of Cuba and each of the various ports of the United States? 2. During what seasons of the year is this intercourse greatest and least? 3. What is the value of this intercourse to the United States? On these three questions much detailed information has been gathered, which is deemed too lengthy for presentation in this preliminary report. However, a sufficient number of facts will be presented to promote an intelligent appreciation of these subjects.

*An official report of 744 foreign vessels sailing from Cuba to the United States during one year states that 367 of these were Spanish, 288 were British, and the remaining 89 belonged to ten other nationalities.

1. WHAT IS THE AMOUNT OF INTERCOURSE BETWEEN EACH OF THE VARIOUS PORTS OF CUBA AND EACH OF THE VARIOUS PORTS OF THE UNITED STATES?

The comparative intercourse between the various ports of the United States and all the ports of Cuba is fairly illustrated in the following table, which, however, refers to a year during which the amount of intercourse was less than the usual annual average.

TABLE NO. 2.—*Statement of the total number of vessels, American and foreign, which entered each of the various* (26) *ports of the United States from all the ports of Cuba, during the year ending June* 30, 1878.

Name of ports.	Number of Vessels. Total.	American.	Foreign.
1. New York	910	701	209
2. Key West	265	234	31
3. Philadelphia	194	167	27
4. Boston and Charlestown	165	113	52
5. New Orleans	128	28	100
6. Baltimore	116	65	51
7. Pensacola	92	40	52
8. Charleston	76	13	63
9. Savannah	55	7	48
10. Pearl River, Mississippi	45	28	17
11. Mobile	34	17	17
12. Saluria, Tex	31	31	......
13. Wilmington, N. C	24	2	22
14. Brunswick	20	7	13
15. Saint Mary's	16	......	16
16. Fernandina	14	4	10
17. Portland and Falmouth	13	9	4
18. Galveston	12	3	9
19. Têche, La	10	10	......
20. Apalachicola	5	4	1
21. Saint Mark's	4	4	......
22. Saint John's	3	2	1
23. Brazos	1	1	......
24. Beaufort	1	1	......
25. Norfolk and Portsmouth	1	......	1
26. Stonington	1	1	......
Totals	2,236	1,492	744

It is noteworthy that of all the vessels cleared from Cuba to the United States four-fifths entered the six ports of New York, Key West, Philadelphia, Boston, New Orleans, and Baltimore—more than two-fifths of these having entered the port of New York alone, and less than two-fifths the remaining five ports combined—and that only 571 of the 2,236 vessels sailed to the eighteen southern ports which are south of Norfolk, Va., and especially liable to yellow fever.

Although Spain, the mother country, imposes from May 1 to October 1 severe quarantine restrictions on vessels from all Cuban ports, whether with or without clean bills of health, yet these ports are not all equally prone to infect the shipping in their harbors; and vessels which do become infected are not dangerous in equal degree to all the ports of the United States. Hence it is of consequence to determine the comparative amount of intercourse from each Cuban port to each port in the United States. The desired facts as to foreign as well as to American vessels were not procured; but the following data as to American vessels alone, and for the year ending December 31, instead of June 30, 1878, as in table No. 2, furnish facts sufficient for a satisfactory estimate. Since the data are derived from the same sources which supplied the materials of table No. 1, they are defective to the same slight extent, and for the same reasons, which were stated when introducing said table.

TABLE NO. 3.—*Total number American vessels cleared from all and from each of ten Cuban ports for United States during year ending December* 31, 1878.

Ports of the United States entered in 1878 by vessels cleared from ten specified Cuban ports.	Havana.	Matanzas.	Cardenas.	Sagua.	Cienfuegos.	Baracoa.	Caibarien.	Trinidad.	Cuba.	Nuevitas.	Totals from ten ports.
New York	160	166	144	77	57	114	40	1	7	1	767
Philadelphia and Delaware Breakwater	11	56	71	35	29	.....	10	18	3	2	235
Key West and Cedar Keys	179	3	29	11	1	.....	3	.....	.....	.....	226
Boston and Charlestown	7	46	4	7	53	5	1	9	1	.....	133
New Orleans and Southwest Pass	60	9	1	2	6	.....	3	.....	.....	.....	81
Baltimore	5	24	30	7	.....	.....	1	.....	.....	.....	67
Indianola	31	.....	.....	.....	.....	.....	.....	.....	.....	.....	31
Pensacola	14	4	8	1	2	.....	.....	.....	1	.....	30
Savannah	8	.....	1	.....	.....	.....	.....	.....	7	.....	16
Pascagoula	10	.....	.....	1	2	.....	2	.....	.....	.....	15
Mobile	4	3	.....	1	.....	.....	.....	.....	.....	.....	8
Charleston	.....	.....	1	.....	1	8	.....	.....	.....	.....	10
Portland and Falmouth	1	.....	2	2	.....	.....	.....	.....	.....	.....	5
North Hatteras	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5
Morgan City	5	.....	.....	.....	.....	3	.....	.....	2	.....	5
Pearl River, Shieldsborough, Handsborough	1	2	.....	.....	.....	.....	.....	.....	.....	.....	3
Brunswick, S. C	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	2
Galveston	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	2
Apalachicola	.....	.....	.....	2	.....	.....	.....	.....	.....	.....	2
Jacksonville	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	1
Fernandina	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Cat Island	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Brazos	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
United States for orders	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	1
Totals	503	313	291	146	152	130	60	28	22	3	1,648

While this table correctly represents the *comparative* intercourse from the specified Cuban ports to the ports of the United States, it must not be forgotten that it inadequately represents the *absolute amount* of said intercourse, because it fails not only to report the fifty to seventy-five vessels which sail annually from five omitted ports, but also to report the seven hundred to eight hundred *foreign* vessels which also sail to the United States. In another particular, still more important, the table is calculated to mislead in any estimate of the number of dangerous risks incurred by the United States from any one of these ports when infected; for a number of vessels sail from each of the chief and most dangerous ports coastwise, and are reported in the table as sailing from its last port of departure, perhaps an uninfected one, without reference to the fact that it had previously been at a dangerously infected port. Some idea of the number of such risks may be derived from the following facts: From that most dangerous port, Havana, there sailed in 1878, *directly* to the United States five hundred and three American vessels, as is correctly stated in the table, but in addition to this number there were one hundred and seventy-six other vessels which sailed, coastwise from Havana; that is, to some other Cuban port. And these one hundred and seventy-six vessels are reported as cleared from their final port of departure, and not from Havana.

Medical records are full of instances where vessels, sailing from some other Cuban port, had become infected really at Havana. During the present year, two vessels at Matanzas were reported to have become infected at Havana, and one vessel entering Philadelphia from Sagua is reported to have become infected at Matanzas.

2.—DURING WHAT SEASONS OF THE YEAR IS THE INTERCOURSE FROM CUBAN PORTS TO THE UNITED STATES GREATEST AND LEAST.

Of the 1,648 American vessels which sailed from the 10 ports of Cuba during the year ending December 31, 1878, the number which sailed during each of the four quarters of the year was as follows:

TABLE NO. 4.

Cuban ports.	Total No. vessels during year.	No. vessels first quarter.	Second quarter.	Third quarter.	Fourth quarter.
Havana	503	109	133	133	128
Matanzas	313	67	148	68	30
Cardenas	291	55	144	69	23
Sagua	146	14	55	51	26
Cienfuegos	152	34	58	42	18
Baracoa	130	23	77	16	14
Caibarien	60	6	23	15	16
Trinidad	28	8	10	7	3
Cuba	22	12	3	3	4
Nuevitas	3	1	1	....	1
Totals	1,648	329	652	404	263

During the year 1877 the corresponding figures were as follows: Of 1,454 American vessels 414 sailed during the first quarter, 548 during the second, 264 during the third, and 228 during the fourth quarter. It thus appears that a larger number of vessels sail from Cuba to the United States during the six months,' April to October, than during the six months from October to April. It deserves notice that the largest amount of intercourse with Cuba occurs during the second quarter of the year, but that positive information was received that this excess occurred more especially during the months of April and May, and not usually in June. Since the four months, June, July, August, and September, are especially to be feared, and since it is during this period that the greatest conflict occurs between sanitary and commercial interests, it was deemed important to determine what proportion of our trade was carried on during these months. It is regretted that the desired data were not obtained except for the ports of Matanzas and Cardenas, but no reason is known why the facts as to these two should not correctly indicate the facts as to the other ports. The facts as to Matanzas and Cardenas are as follows:

TABLE NO. 5.—*Statement, for five years, of the number of vessels of all nationalities which cleared annually for the United States from the ports of Matanzas and Cardenas during the four months, June to September, and during the whole year.*

Ports.	1874.		1875.		1876.		1877.		1878		Totals for five years	
	For the four months.	For the twelve months.	For the four months.	For the twelve months.	For the four months.	For the twelve months.	For the four months.	For the twelve months.	For the four months.	For the twelve months.	For the 4 months of the 5 years.	For the five years.
Matanzas	100	529	136	514	61	418	78	357	145	425	520	2,243
Cardenas	58	405	89	445	59	394	79	297	126	350	411	1,791
Totals	158	934	225	959	120	812	157	654	271	775	931	4,034

Thus it is seen that considerably less than one-fourth of all the vessels which sail to the United States from Matanzas and Cardenas habitually sail during the four months, June to September.

3. WHAT IS THE VALUE TO THE UNITED STATES OF THE INTERCOURSE WITH THE PORTS OF CUBA?

The day may come when the people of the United States will demand whether their welfare would not be best promoted by suspension of intercourse with Cuba during certain months of the year; the day has come when this intercourse is much restricted; and the day is always at hand when an intelligent people should be instructed to what extent their pecuniary as well as their sanitary progress is involved in every legislative measure. Commercial interests are so much prized, sanitary interests so ill-appreciated, that vague and absurdly exaggerated statements of the value of the Cuban trade find credence.

In January, 1879, an intelligent but interested witness testified before a committee of distinguished Congressmen and of medical experts engaged in the investigation of the yellow fever epidemic of 1878 that the sanitary restrictions on the trade of New Orleans with the West Indies had during this one year injured that city to the extent of about one hundred millions of dollars. It is instructive that this evidence passed unquestioned in spite of the fact that the total annual exports of Cuba *to all nations* has rarely if ever exceeded that sum.

The most complete and reliable data in hand are for the year ending June 30, 1878, and some few of these data are submitted with the warning that all the figures for this year are somewhat less than the usual annual averages of recent years, owing to the less productiveness of this year.

The total exports of Cuba in 1878 were $70,881,552, and of this sum there were $56,695,278 of saccharine products and $13,213,690 of tobacco.

The United States took from Cuba $58,885,162 of its exports (or, deducting "specie," $56,901,332 of Cuban products) and exported to Cuba, exclusive of "coin and bullion," $11,365,013 "merchandise." Thus the total trade with Cuba in 1878, *not the profits on this trade*, which must necessarily have been very much less, consisted in the interchange of products and merchandise, of which the total value was only $70,250,125, while the annual average for the past ten years has not been more than about $80,000,000.

This trade, in 1878, was distributed as follows:

TABLE NO. 6.

	Imports.	Exports.	Total.
New York	$44,530,355	$7,469,977	$52,000,332
Philadelphia	4,915,311	1,065,893	5,981,204
Boston and Charlestown	4,559,228	178,187	4,737,415
New Orleans	2,043,697	188,813	2,232,510
Baltimore	1,917,597	135,754	2,053,351
Key West	664,292	626,624	1,290,916
Portland and Falmouth	209,038	767,077	976,115
Saluria, Texas	....	379,951	379,951
Pensacola	2,320	109,149	111,469
	58,841,838	10,921,425	69,763,263

The insignificant remainder ($486,862) of this trade was transacted with the ten southern ports which follow in the order of their relative importance: Pearl River, ($68,667,) Mobile, Galveston, Savannah, Wilmington, Charleston, Brunswick, Saint Marks, Fernandina and Brazos, ($10,056.)

So many intricate problems enter into the calculation of the profits derived from commerce that even commercial experts would find it difficult to estimate the value to this country of its trade with, Cuba, and still more difficult to estimate the much smaller profits which would be lost to the United States by a suspension of or by restrictions on this trade during a few months of each year.

None the less, the facts given seem to justify the following conclusions: The United States is an indispensable market to Cuba. Suspension of intercourse during a few months would tend to force the Cuban trade into the remaining months of the year rather than to seriously diminish this trade. The chief injury to the interests of the United States would fall upon the shipping and sailors temporarily deprived of occupation, and, finally, present sanitary restrictions on this trade certainly do not cause to the United States the great pecuniary loss which the people are incessantly taught is thereby inflicted.

II.

ENDEMICITY OF YELLOW FEVER IN CUBA.

The vagueness of significance attached to the words *endemic* and *epidemic*, whether as defined by medical lexicographers or by common use, renders these words so unsatisfactory that whoever would write with accuracy is forced to explain. As usually defined, an endemic disease is due to a local cause, and is peculiar to certain localities or countries wherein it prevails habitually; but this habitual

prevalence need not be persistent throughout every month of the year, nor even during every year. Thus this word ranges through undefined limits, so that when an endemic prevails with great severity custom permits it to be termed either an epidemic, or an endemo epidemic. A greater objection to the word is found in defining it to be "due to a local cause." What is due? Is it the *origin* or the *propagation* of a disease by local causes which entitles it to be classed as an endemic? While all admit that local causes have much to do with the *propagation* of yellow fever, it is very doubtful whether this disease has its *origin* any more in such causes than have the eggs of a tape-worm, the achorion of the barber's itch, or the virus of small-pox or of syphilis. Just as sugar cane is *propagated* only when under the influence of certain local causes, but can never be *originated* by them, so many hold as to the origin and propagation of yellow fever. Hence, the word endemic will not be used to imply that either this or any other disease which there may be occasion to thus designate owes its *origin* necessarily to local causes.

In reference to the endemicity of yellow fever in Cuba, its history, extent, and causes in many different localities thereof, so vast a mass of valuable statistical and other facts has been gathered, that it is impossible to condense these into a brief preliminary report, and the difficulty of properly treating the subject is greatly increased by the fact that so much time was engrossed in collecting these facts that very little has been left for their thorough study and proper mental digestion. As this holds, in some measure, true in reference to all of the special subjects investigated, generalities, rather than details, must be permitted.

The endemicity of yellow fever is so intimately associated with its first appearance, its history, and its causation that a few facts must be presented, not only on the history of yellow fever in Cuba, but also on the history of this disease prior to the year 1761, when it first appeared in Havana,* so far as its first distinct recognition and authentic record go to establish this first appearance.

The history of yellow fever prior to 1761 requires to be divided, for present purposes, into two epochs; first, from the discovery of America in 1492 to 1640, and second, from 1640 to 1761. A third epoch from 1761 to 1780 will be subsequently considered in relation exclusively to Cuba. Those familiar with the history of general literature, and especially of medical science from 1492 to the present day, need not be reminded through what an abyss of illiteracy, medical ignorance, and quackery civilized nations have slowly progressed to the present day; and that only in recent times have there been ample means to publish, and any considerable number of medical men competent to observe and to record what was worthy of publication. Hence none should be surprised that, though the records of yellow fever are superabundant in modern times, these records should become less and less satisfactory until, as we pass backwards, we reach an epoch, as is that from 1492 to 1640, of vague allusions and inconclusive descriptions—therefore an epoch open to suspicion and hypothesis.

1492 to 1640.—Historical records justify the suspicion that yellow fever prevailed in San Domingo in 1493–1494 and subsequent years, in Porto Rico as early as 1508, in Darien in 1514, in Guadaloupe in 1635, &c. Knowledge of nature's laws, of disease, of yellow fever particularly, and of other subjects relating to the present topic, convert the suspicion justified by scanty historical records into an absolute conviction that yellow fever was at least coeval in some of the West Indies with their first settlement by Europeans.

1640 to 1761.—Notwithstanding this conviction the earliest authentic historical notices of unquestionable yellow fever are those which record epidemics of this disease at Guadaloupe in 1640, Martinique in 1641, and Barbadoes in 1647. Memoranda are in hand which indicate the prevalence of yellow fever from 1640 to its first recorded appearance in Havana in 1761, in not less than thirty different places, more than one hundred times; and among these in not less than ten different places nearly fifty different times in these United States.

YELLOW FEVER IN HAVANA AND CUBA, FROM 1761 TO 1880.

The year 1762 was a notable one to Havana, since it was besieged, captured, and held by an English force of some thirty thousand soldiers and sailors for more than a year. In that year a yellow-fever epidemic committed destructive ravages, and it is not singular that many historians should have committed the apparently inconsequent error of stating that the disease first appeared in this notable year. However, ample historical proofs have been secured to establish that the first epidemic occurred in 1761, and the second in 1762.

Although the disease made its first historical appearance in 1761, yet there are historical allusions sufficient to justify strong belief that yellow fever had existed in Havana and Cuba in four of the eight years 1648 to 1655. However, in view of this suspicion it deserves notice that, though Spanish literature is unusually rich in valuable histories of Cuba, no allusion has been found justifying even a suspicion that yellow fever was known in the island from 1655 to 1761. On the contrary, repeated references are made to the remarkable salubrity of Havana, and to the non-existence of any exceptional or devasting diseases during this interval. While such references cannot be accepted as absolute proof, they yet tend to show that if the disease did exist from 1655 to 1761, it could not have prevailed either habitually or severely.*

Convincing historical evidence has also been secured that since 1761 yellow fever has been persistently endemic in Havana, present every year from then to the present time. Reference to any medical authorities on the geographical history of yellow fever will show records of the occurrence of this disease in certain specified years, interrupted by intervals of unrecorded years; thus leading to the false inference that the disease did not prevail during these unrecorded years. On this subject all of these authorities dangerously mislead the profession, for the truth is now, as it has always been since 1761, that yellow fever prevails in Havana every year without exception, and that the years specially recorded were simply years when the disease prevailed to somewhat greater extent than during the intervening years which these authorities omit to record.

IN WHAT PLACES AND TO WHAT EXTENT DOES YELLOW FEVER PREVAIL IN CUBA?

Reports have been secured from twenty seaboard towns, including "the ports of entry," and from more than twenty of the chief inland towns; these record the facts for both the civil and the military population, but they include so wide a field and so many instructive details that it is impossible to state at present any more than general results.

The most general result is that yellow fever habitually prevails in every place in Cuba from which reports were received, provided these places are of any size or commercial importance and contain any considerable number of unacclimated persons to furnish food for the wide-spread poison.

In this particular, also, medical authorities, as well as intelligent residents of Cuba, have for the most part misled the profession. Before leaving the United States, the most absolute assurances were given by natives or ex-residents of Cuba, and even in Cuba itself these assurances were confidently repeated, that yellow fever never occurred in this, that, or the other place. Diligent inquiry was made for all such accessible places, and diligent investigation invariably proved that these assurances were false and that they were founded upon a *comparatively slight prevalence* of the disease, due in large measure to the small number of unacclimated visitors or residents at such places. Detailed proofs of these facts are possessed in abundance. It is very certain that the prevalence of yellow fever is not equally marked in all places. This varies greatly in different places and in different years at the same place; and this variation is, at times, independent, apparently, of the amount of unacclimated material.

While the records of all reported places cannot now be given, nor the records in full of any one of the forty-odd places, the following facts derived from the statistics of the military hospitals (which begin with the year 1851) give some proofs of the endemicity of yellow fever at fourteen of the fifteen "ports of entry," Taza being omitted because too insignificant to require a hospital. They will be considered in alphabetical order; and it must be remembered that, because in certain years no cases of yellow fever are reported in the military hospitals, this does not prove that the civil population was also exempt, and very probably was due to the absence during said time of unacclimated soldiers:

1. *Baracoa.*—There were cases of yellow fever in the military hospital every year since 1865, except from February, 1873, to May, 1876.

2. *Caibarien*, an insignificant village, and the seaport of Remedios, about five miles distant.—Yellow fever occurred in the hospital of Remedios every year since 1867, except in 1873.

3. *Cardenas.*—The records extend only from 1853 until 1871. Yellow fever occurred in every year except in 1856. Other evidence proves the annual presence of yellow fever for many past years. In 1879 the disease is reported to have been worse than ever before.

4. *Cienfuegos.*—Yellow fever every year since 1850, except in 1862 and 1874. In 1879, there were very few cases.

5. *Cuba (Santiago de).*—Yellow fever prevailed every year, and nearly every month, from 1850 to the present time.

6. *Gibara or Jibara.*—Yellow fever occurred every year since 1868; also for the same time at Holguin, the inland town of which it is the port.

7. *Guatanamo.*—Yellow fever every year since 1866.

8. *Havana.*—Yellow fever every year and every month since 1850.

9. *Manzanillo.*—Yellow fever every year since 1866.

10. *Matanzas.*—Yellow fever every year since 1856, except in 1866. The disease was severe in 1878, and greatly afflicted the shipping, while in 1879 the disease has not been severe either on shore or in the harbor. Other evidence proves that for very many years yellow fever has prevailed annually in Matanzas.

11. *Nuevitas.*—Yellow fever every year since 1868. This is the northern port of the far inland and comparatively elevated city of Puerto Principe, which various authorities record as free from yellow fever, and as to which several physicians in Havana asserted in 1879 that it had never had yellow fever until the insurrection (1868–1878) caused an

* Havaña was founded in 1515-1519; had a population in 1600 of about 3,000, in 1700 about 9,000, and in 1792 about 50,000.

* Since the first appearance of yellow fever in some of the West Indies has been attributed, by some few writers, to the first importation of negroes, it is worth recording that "the first three hundred African slaves were brought from San Domingo to Cuba in 1523;" that in 1763 several thousand were introduced; and that in 1774, when the first census of Cuba was taken, there were in the island 75,180 colored population, of whom 44,333 were slaves.

ingress of troops. The military records prove the existence and considerable prevalence of the disease in Puerto Principe every year since 1850, except in 1866.

12. *Sagua.*—Yellow fever occurred in 1869, 1870, 1871, and this hospital was suppressed in 1873. Yellow fever is endemic, but not usually very prevalent, at Sagua, as proved by other evidence.

13. *Santa Cruz.*—Every year since 1868, except in 1876 and 1878.

14. *Trinidad.*—Every year since 1853, except in 1863.

It will of course be understood that while cases of yellow fever occurred during the years above reported, yet that the number of cases during said years varied greatly; there having been in some few of these years perhaps only one case in some one of the military hospitals.

At Havana the yellow fever endemicity is most marked; indeed it would not convey a false idea to state that the disease is generally epidemic from June to October, and endemic during the remaining months of the year. This statement is illustrated by the following facts in reference to the past ten years—1870–1879.

During this period the minimum and maximum number of deaths which yellow fever caused during each month will be stated, reminding the reader that the number of deaths imply about treble said number of cases.

TABLE NO. 7.—*Monthly maximum and minimum deaths by yellow fever in Havana, during the ten years, 1870–9.*

Months.	Minimum.	Maximum.
January	6	32
February	4	24
March	4	32
April	4	37
May	13	103
June	66	378
July	68	675
August	70	416
September	35	234
October	28	185
November	5	150
December	9	82

In no one of the ten years, 1870–1879, have there ever been fewer deaths than in the first, nor more than in the second column, and the total deaths by yellow fever for each year were as follows:

TABLE NO. 8.—*Total deaths by yellow fever in Havana.*

In 1870	665
In 1871	991
In 1872	515
In 1873	1,244
In 1874	1,425
In 1875	1,001
In 1876	1,619
In 1877	1,374
In 1878	1,559
In 1879, to October 1	1,353

From one-fourth to one-half of these deaths occur in the military hospital, an important fact, which, in connection with many others, proves how erroneous is the idea that yellow fever is especially and exceptionally severe in the shipping and harbor of Havana.

It is believed that the above selection, of a very few from the very many facts collected, will suffice for the present to illustrate the endemicity of yellow fever in the most important seaports of Cuba. Residents of the mountains and of other secluded rural portions of Cuba suffer with the disease when visiting infected towns, and this fact serves to prove that the poison has no such permanent lodgment in these places as is required to acclimatize a population, and also that the causation of the disease must be sought for in other conditions than those common to these rural places and to the towns habitually infected.

III.

THE CAUSES OF THIS ENDEMICITY.

Yellow fever was not endemic in Havana prior to 1761, yet before this time the geography, geology, and meteorology of Havana were what they continue to be.

In 1805 Mr. Hill, United States consul at Havana, reported "it is from June to November that yellow fever is most prevalent and fatal. Indeed it is seldom known at any other season." It is now and has long been well known to be present every month of every year.

If such high authorities as Dutroulau, Cornillac, Béranger, Féraud (and there are none higher in yellow fever literature) are to be credited in their statements of facts, then this disease is occasionally epidemic, but not persistently endemic in any of the Lesser Antilles, (prevailing in Martinique, Guadaloupe, Trinidad, &c.) in the same epidemic manner it does in portions of the United States, and not in the endemic manner characteristic of Cuba, and especially of Havana.

Thus, then, it appears that the prevalence of yellow fever in Havana during certain months only has so increased that the disease is present every month, and that the causes must be sought in conditions other than those which existed there prior to 1761, and which still exist in certain rural localities of Cuba and throughout most of the other West India Islands.

What are these different conditions? History records that "previous to 1762 Cuba had no commerce, the country lived by smuggling," and that "in 1818 the port of Havana, in common with the others of the island, was by law opened to foreign commerce."

Steam navigation, introduced in 1819, has gradually increased the intercourse between Havana and the principal ports of Cuba, while in 1848 their intercourse with other countries began to be increased by steamship lines.

From 1836 to 1863 nearly a thousand miles of railroad were constructed, linking the chief seaports more closely, not only with each other but also with the chief inland towns, and during the insurrection of 1868 to 1878 the introduction of unacclimated persons was unusually great, as was their intercourse between Havana and other infected ports on the one hand and inland towns on the other. With these various events the prevalence of yellow fever has apparently increased. Cuba differs from the Lesser Antilles in that its products are more valuable; therefore its commerce by land as by sea is more extensive, and its population, unacclimated and acclimated, is more numerous and aggregated more densely in cities, which are in frequent and rapid intercourse with each other.

In addition, Cuba makes no such efforts to limit the spread of yellow fever as have been apparently so successful in Martinique and other West Indies. Its military as well as its civil hospitals, its official as well as unofficial physicians, register yellow fever in their records and in their certificates side by side with small-pox as a "*contagious disease,*" and while many of its most eminent physicians deny that the disease is contagious from person to person, no one of these was encountered who did not advocate that the disease was portable and could be spread by importation. Notwithstanding all this, so far is Cuba from efforts to control the propagation of yellow fever that much is done which is calculated to greatly favor this. Three illustrations will be given.

(*a*) In July, 1879, the chief military hospital at Havana, located on the edge of the harbor in one of the notoriously most infected wards and localities of the city, was inspected. It contained many cases of yellow fever, some of which were originating therein daily. A large room on the ground floor of this hospital contained new blankets and other hospital supplies of clothing in very large quantities, and to the value of $80,000, and it was found that these supplies were for *distribution* to the other military hospitals scattered over the island.

(*b*) Cuba has for years been cursed with a deteriorated paper currency, much of it so dirty that it stinks, and some of it is so foul that it has been seen conveying even sticking fish scales from person to person.

(*c*) After October 4, 1879, although there had been during the week twenty deaths in Havana, with not less than eighty cases of yellow fever existing on that day, and in the harbor nine infected vessels, yet "clean bills of health" were issued by Cuban officials to vessels sailing from that harbor.

These three instances will suffice to compare Spanish practice with the theory of Spanish law and of Spanish medical officials, and also to show that if these theories of yellow fever be correct, then the exceptional prevalence of yellow fever in Cuba, as well as its importation thence to foreign countries, needs little further explanation. Having the poison, all the requisite climatic conditions for its propagation, and constant supplies of unacclimated food for the poison, ample means are provided to bring the one in contact with the other.

In connection with the facts stated, it is pertinent to add, that small-pox has also become endemic in Cuba, and especially in Havana, where cases occur every month, so that the annual mortality during the past nine years, 1870–1878, has been as follows: 618, 1,126, 174, 47, 772, 711, 160, 97, 1,225. Now, this small-pox mortality is chiefly in the civil population, and if the mortality by yellow fever in the same population were compared with the former, it would probably be found that small-pox is as exceptionally and almost as severely prevalent as is yellow fever.

Further, it should not be forgotten that while none of the causes referred to suffice to always explain all the variations in the prevalence of yellow fever during certain seasons and years, yet that this *terra incognita* of this disease is also a *terra incognita* of small-pox, of malaria, and of other diseases. Science has no right to expect explanations of the mysteries of the one, while still unable to solve the similar mysteries of other much more familiar and widely prevalent diseases.

The whole truth has very certainly not been fathomed; but this much of it is indisputable: Wherever in Cuba a town exists which has the greatest commercial intercourse, the most numerous unacclimated population, the least exposure to the winds, and houses the most crowded together, densely inhabited and filthy, the worst ventilated and drained, there a town will be found wherein the endemic prevalence of yellow fever is most marked.

REMARKS ON CLIMATE IN CONNECTION WITH THE PREVALENCE OF YELLOW FEVER.

The Commission is in possession of the meteorological records of Havana for twenty years, recorded in the metrical system, and occupying hundreds of printed pages. It has, in addition, records for one or more years of several other places, in fact of all of the few places which have such records.

From these records an expert in meteorology may possibly be able to add to our present knowledge. In the mean time, a few facts in reference to a subject which all concede has an essential connection with yellow fever seems imperatively called for in any consideration of the causation of the endemicity of this disease.

1. *Temperature.*—The "annual mean" is conceded to be the factor of greatest moment in this connection. This, in Havana, varies in different years from 77° Fah. to 79°. The mean temperature of the hottest month varies from 82° to 84°.5, and of the coldest month from 72° to 75°.7. While the minimum temperature is rarely as low as 50°, the maximum is as rarely 100°. There are no records, nor any recollection of frost having ever occurred, except on December 24 and 25, 1856. This, of course, has no reference to the sparsely inhabited mountains, some of which attain in the eastern end of the island an altitude of more than 8,000 feet.

Notwithstanding the unquestioned influence of heat, yellow fever is by no means always most prevalent when this is greatest. From Cuba to Guiana the disease has repeatedly prevailed with little severity during the hottest summers, and with great severity during the winter.

2. *Rains and moisture.*—The average annual rain-fall is about 50 inches, and the number of rainy days 102. There is no reason to believe that in any warm climate where there is abundance of water to evaporate there can ever be a lack of as much atmospheric moisture* as the yellow-fever poison probably does require. Dutroulau asserts, as to Martinique, "often after and during the driest season yellow fever has committed its greatest ravages." The same fact has been observed in other places.

3. *Winds.*—No connection has ever been established between the prevalence of yellow fever and the prevalence of the wind from any special quarter. While there is evidence that violent winds, storms, or hurricanes exercise an unfavorable influence on those dangerously sick with yellow fever, there is evidence fully as convincing that such winds tend, as any currents of uninfected air must tend, to dilute the poison, thus to diminish its activity, and thereby to reduce the number of cases attacked.

4. *Electricity.*—Repeatedly, as in New Orleans and the South in 1878, violent epidemics have been attributed to the absence of electrical storms and to a diminution of the quantity of electricity in the air; probably even oftener the reverse has been maintained, especially in Vera Cruz and in the West Indies.

5. *Magnetism.*—For a series of years the College of Belen in Havana kept a record of the variations of terrestrial magnetism. In 1868 Dr. Poggio, of the military hospital in Havana, made a careful comparison, day by day, of the variations in both yellow fever and terrestrial magnetism. "The result of a very careful investigation was total disappointment."

6. *Ozone.*—In the severe epidemic from October, 1862, to February, 1863, at Santa Cruz, in the Canary Islands, ozonometrical observations were made, which tended to show an increase of ozone as the epidemic declined; and Dr. Fuzier, chief of the French military hospital at Vera Cruz, 1861–1865, also testifies to having "proved the feeble quantity of ozone in places which yellow fever prefers;" but until the chemical tests for ozone are more satisfactory, and such observations are repeatedly confirmed, science must maintain its skepticism.

7. *Alkalinity of the air.*—Dr. Carlos Finlay, a chemist and distinguished physician of Havana, claims to have discovered an important correspondence between the prevalence of yellow fever and the varying degree of alkalinity of the air at Havana and several adjacent places. This subject will hereafter receive the special attention of a member of this Commission.

In fine, science has thus far failed to prove the essential connection with yellow fever of *any one* meteorological factor, except heat; and what duration and degree of this are requisite is very indefinitely known. It should, however, not be forgotten that this indefiniteness of knowledge is by no means limited to yellow fever, but applies to other diseases, as also to the varying crops of vegetables and the annually varying productiveness of animal life. Some of the most thoughtful students of yellow fever, while conceding that no one meteorological factor suffices to account for the propagation of the disease, are yet very firmly convinced that there is some undetermined combination of these factors which is essential. This conviction is based on the fact that in places where yellow fever frequently prevails as an epidemic there had been repeatedly present, without giving rise to an epidemic, a combination of the three factors most usual and important, namely, the presence of the poison, as proved by cases of the disease, an ample supply of unacclimated persons, and a persistence of apparently the very same insanitary local conditions observed during seasons when the disease was epidemic.

It will be very difficult, if not impossible, to determine what may be this supposed meteorological combination until vital statistics have so greatly improved that the influence of all other disturbing causes, such as the varying number of the unacclimated exposed to the poison, the quality as well as quantity of the insanitary conditions, &c., can be rigidly eliminated from the problem. Finally, it should not be overlooked that climatic conditions may exercise a twofold influence, one favorable to the poison, the other favorable to preparing the individual for its reception.

* The annual mean "relative humidity" varies in different years from about 73 to 74.3, and that of different months of the year from 66 to 79.

IV.

THE INSANITARY CONDITION OF THE PORTS OF CUBA AND THE CAUSES THEREOF.

This subject will be illustrated sufficiently for present purposes by the consideration of the four principal ports, Havana, Matanzas, Cardenas, and Cienfuegos, and especially of the first. No facts have been procured as to other ports indicating that their condition differs from these four in any important particulars.

The actual sanitary condition of every place is best tested by its annual death-rate, which necessitates for its calculation the number of the population and the number of the deaths which occur every year in this population. In Cuba it is unusually difficult to procure these data. The last trustworthy official census published was for the year 1862, (sometimes designated the census of 1861, also of 1863,) and a copy of this could not be procured until a short time before the commission's departure from Havana. The more recent census of 1877 has not yet been published, and much delay and difficulty were encountered in obtaining from official sources a few insufficient, and at times discrepant, data in manuscript from this census. So much care is required in handling these data of population that errors are constantly committed by nearly all who treat the subject. Two frequent sources of error will be alluded to. One is the error due to such a fact as that there is a *district* of Matanzas, in the *city* of Matanzas, in the *municipality* of Matanzas, in the *jurisdiction* of Matanzas, in the *province* of Matanzas, and some who state the population of *Matanzas* mean one of these political divisions, while others mean another, and there is frequent omission to designate which division is meant. Another error is due to the failure, often unavoidable, to keep the civil apart from the military population.

Still greater difficulties are encountered in establishing the number of deaths which exactly correspond to any given population. The statistician is perplexed, not only by the confused mode of reporting dead civilians and soldiers variably intermingled, but also by the prevailing Cuban custom of reporting deaths by church parishes, which do not correspond with the political divisions in the census of the population. This Cuban habit of thus living politically and dying religiously is most vexatious to the statistician, if not to the moralist, and when considered in connection with other confusing perplexities, all recorded in the Spanish language, some idea may be formed of the care and labor required of one not conversant with this language to avoid being led astray. The following Statistical Table No. 9 has been compiled with such care that any errors which it may contain must be too trifling to invalidate the general results. But before proceeding to the examination of the mortality statistics of the four principal ports of Cuba a few words by way of introduction will prove instructive in reference to the

DEATH-RATE OF CUBA.

Dr. Melero published in 1878 an able article on the vital statistics of Cuba, apparently to "show that the mortality in this island is not so great as represented by many, and that the climate is not as deadly as it has been believed to be." "It appears from these statistics that the death-rate in Cuba in 1827 was 26, in 1846, 24, and in 1861, 32 per 1,000 population." The three years mentioned are those of the most reliable official censuses.

TABLE No. 9.—*Statistics of the population, births, and deaths in four of the principal ports of Cuba for the years* 1876, 1877, *and* 1878.

Ports.[1]	Years.	Civil population, census 1877.					Births or number of baptisms.			Deaths.			Death rate per 1,000 population.
		Whites.[2]	Colored.	Males.	Females.	Total.	Whites.	Colored.	Total.	Whites.	Colored.	Total.	
Havana[3]	1876						3,562	1,333	4,895	5,290	2,148	7,438	
	1877	147,798	47,639	115,278	80,159	195,437	3,653	1,377	5,030	4,986	2,153	7,139	
	1878						3,665	1,310	4,975	5,996	2,598	8,594	43.9
Annual average of three years.									4,967			7,724[3]	39.5

[illegible]

[illegible] Havana, and [illegible] after the establishment of [illegible] between these two places.

[illegible] THE IN-SANITARY CONDITIONS OF HAVANA, ETC.

[illegible] Cuba with swamps adjacent to the localities [illegible] has provided these places with a meager or [illegible] water-supply; has constructed the island, for the most part of coral limestone or other porous, friable rocks, covered to only a slight depth with surface soil; and has located this fertile island, so tempting to man's greed of gain, in a climate which favors to the utmost decomposition, putrefaction, and the propagation of vegetable and animal life. Man may hold nature directly responsible for any in-sanitary evils resulting from these conditions, which, however, if history be true, failed during centuries to produce either small-pox or yellow fever. But for in-sanitary conditions other than these man is forced to consider to what extent he himself is responsible. Mankind in Cuba is by no means exceptional in having not only neglected this responsibility, but also in having, from ignorance and avarice, even abetted nature in its warfare against him. He imperatively needs an abundance of potable water, an unpolluted soil, and, above even these, an unlimited supply of pure air. What has been done and left undone in Havana to secure these requisites to healthy life?

1. WATER SUPPLY.

About four miles west of the entrance to the harbor of Havana the river Almendares empties into the sea. It is fed chiefly by springs, and the water is said by experts to be good. Since about 1600 Havana has received its chief supply from this small stream—first by means of the "Zanja," or water-course (in truth a ditch); second, in 1835, by the "Aqueduct of Ferdinand VII;" and third by the "Aqueduct of the Vento,* or of Isabel II," which, begun in 1859, has cost more than $3,000,000, and will require nearly as much more to complete. Although Havana now obtains its water through all three of these channels, these fail to furnish it with a supply adequate, either in quantity or quality. The uncompleted "Aqueduct of Isabel II" is a monument of the engineering skill of Colonel Albear, and if ever completed will furnish the city with an ample supply of pure spring-water. From the point where completed as much of this good water has been directed into the Aqueduct of Ferdinand VII as this has capacity to carry. Since this is totally insufficient, the water of the Zanja is still used, in whole or mixed in part with the other supply, throughout a large portion of the city. The water of the Zanja flows for some four miles through unprotected mud-banks, the fluids from many houses drain into it, men and horses bathe, and dead bodies have been seen floating in it. It cannot be pure. But the impurity of this supply of water to a portion of the population is an evil slight in comparison to that which results from the inadequate supply of water of any kind to the whole population. So costly and so inadequate is this supply that very few houses of the working class are provided with it, and a large portion of the population purchase their water daily in kegs and carboys from street-vendors. This mode of obtaining water prevails in Matanzas, Cardenas, Cienfuegos, and many other places, and in most of these to even greater extent than in Havana.

The insanitary evils which result from this general insufficiency of water in a tropical climate are much greater than would ensue farther north. When bathing becomes difficult, and washing so exorbitant that it costs from twenty to thirty cents in gold to have a gentleman's shirt washed, it is not strange that personal cleanliness should be so little attended to that an unusually large portion of the people are offensive to the smell. This lack of cleanliness extends within the houses, into the unpaved streets, the stables, markets, and for the most part everywhere. Farther details are useless, as also insistance upon the pollution of the soil, and of the air, and of other manifest evils, which necessarily result from an insufficient supply of water. It should never be forgotten that "clean water, adequately used, is among the simplest, safest, best of antiseptics," and that the people of Havana and other cities are very insufficiently supplied with this antiseptic.

2. SOIL.

While a varying proportion of Havana, Matanzas, Cardenas, and Cienfuegos is built upon ground elevated from ten to one hundred feet above the level of the sea, another very considerable portion occupies the site of former mangrove swamps, which have been filled up, in large part, with the refuse and garbage from the streets. Swamps of this kind still lie contiguous to all of these cities. A very large proportion of the population live where the subsoil water is reached in from two to six feet of the surface, and it is very common to find privies wherein the contents rise and fall with the tide. In higher localities the thin surface soil and the foundation rocks† beneath it are extremely porous, and permit a high degree of saturation from the subsoil water, from the frequent and abundant rains, and from excrementitial fluids. So great is this saturation, and the defective structure of the houses, that a moisture-mark is found high up on the walls even of many houses located from fifty to one hundred feet above the sea.

As a general rule good drainage is found in no parts of these cities, except in the comparatively inextensive localities where nature has needed no assistance. One is often astounded by the impassable mud holes, and by the green, slimy, stagnant water present in the streets and in the back yards of even a locality such as the Pueblo Nuevo Ward of Havana, which is situated so admirably for good drainage that but little labor would be required to make it perfect.

A comparatively small number of the streets in the most densely populated portions of Havana have sewers, some of which empty into the harbor and others into the sea. A well-informed civil engineer testified that the sewers of only three streets subserved any good purpose, and that the remainder were so faulty that the city would be better off without them. Covered by grating having large interspaces, the dirt and refuse of the streets find such ready entrance that a number of these sewers were seen filled up with solid materials to within a few inches of the grating. Since very few houses are connected with these sewers they are the less offensive, but no one who has seen them can find any words, except of unhesitating condemnation, for their grossly defective structure. Etiologists have repeatedly associated the causation of yellow fever with upturning of the earth, so that this is prohibited during the summer in some parts of the United States. If there be in Havana any such prohibition this was certainly not enforced during the summer of 1879.

* Springs which formerly emptied into the Almendares.
† Specimens of these are in the possession of the National Board of Health.

4. AIR.

The facts just stated in regard to the water supply, and to the soil, are potent and incessant causes for pollution of the air. Among other such causes will be mentioned those which have connection with the streets and houses.

5. STREETS.

The older a Cuban city, or any part thereof, the narrower the streets. About one-fourth of the population of Havana live within the now demolished walls, and this "intramural" population possesses streets so narrow that on every corner is posted either "up" or "down," to indicate to all vehicles that they must pass only in the direction indicated. As time extended the city farther and farther beyond its walls the streets gradually became wider, until some attained the ordinary dimensions usually found in the United States. Matanzas, Cardenas, and Cienfuegos were founded subsequently to Havana, in the order mentioned; therefore Matanzas has many narrow streets, but not as narrow as Havana; Cardenas few, and Cienfuegos none. The narrower the streets the less well ventilated the houses thereon, and a large portion of Havana suffers severely from this cause.

About one-fourth of the population of Havana live on paved streets, which are as well paved and kept as clean, probably cleaner, than is usual in the United States. The remainder live on unpaved streets, which for the most part are very filthy, and not a few of them are, at times, impassable in a vehicle. Rough, muddy, or both, many of them serve admirably as permanent receptacles for much decomposing animal and vegetable matter. In fine, more than half the population of Havana live on streets which are in a foully insanitary condition; but these streets, though so numerous, are not in the track of the pleasure tourist. In this capacity one of the members of this commission spent ten days in Havana in 1856, but never looked for, and therefore never saw, most of the evils which he now testifies to with emphasis.

6. HOUSES.

Four-story houses are the highest in Havana, and exceedingly rare; three-story houses are infrequent, and so few are the two-story houses that more than nine-tenths of all the houses were, in 1862, and are still, one-story houses. These one-story houses occupy very little space; they have no back-yards, properly so called, but a court or narrow vacant space into which sleeping-rooms open at the side; in direct contact with these are the kitchen, privy, and often the stables, which terminate this court. There are no storerooms, pantries, closets, or other conveniences for household supplies; but there are commonly four groceries on the corners of each square from which table supplies are procured at each meal. In Havana some of the floors, in Matanzas more, in Cardenas and Cienfuegos many, are of earth or of planks almost in contact with the wet soil. In Havana most of the floors are of brick or stone paving. Ventilation between the ground and the floor is almost unknown in Cuba. In every city most of the floors are on a level with the sidewalks, and many are even lower than the level of the streets. Most of the houses in Havana and many in other cities are of "mamposteria,"* or rubble masonry, which is very porous and absorbs readily, as the wall-moisture abundantly testifies. The roofs are of tile and excellent. The ceilings are high, and the doors and windows are generally very large; but this is true rather for the front and rear of the main building than for the side rooms which open into the court, and are also occupied as sleeping apartments. The privy is almost a part of the kitchen; it consists of an excavation which often extends several feet under the stone flags of the court; it is never emptied until it will hold no more, which seemed generally to be from five to ten years; it has no ventilating pipe, and belches forth its nauseous odors at times even to the front door. Nothing more unwholesome and disgusting than the privies of Havana and of Cuba generally can be conceived. They are so bad they cannot be worse. In juxtaposition with the privy is another excavation to receive the filthy refuse-water of the kitchen, laundry, and household generally, for police regulations prohibit the discharge of such water into the streets, except while it is raining. This refuse-water is said to undergo a putrefaction which renders it intolerably offensive. It notably aids the contents of the privy to saturate the soil beneath the house. The kitchen is usually under the same open shed with the privy, and often in immediate contact with these is a stable. So near are horses kept to sleeping apartments that farcy would be more frequent than it is if the horses were affected with it to a larger extent.

More cheerless and comfortless houses than those occupied by the working classes and the people generally would be difficult to find. Since water is ill supplied the people are not more cleanly in their houses than in their persons. But as badly constructed and kept as are their houses rent is rendered very high, as are also food and clothing, by taxation and by export as well as by import duties. As one illustration of this, when flour was $6 per barrel in the United States it cost in Havana $15.50. Owing to such causes most workmen, even those receiving from $50 to $100 wages per month, live in such small tenement-houses as have been described. It is very rare for a workingman to have a house, however small and mean, for the exclusive use of himself and family. He is forced to rent out every room, reserving for his own family one, perhaps two. The result is

* Specimens are in possession of the National Board of Health.

By the terms of the act "to authorize the Secretary of the Treasury to contract for the purchase or construction of a refrigerating ship for the disinfection of vessels and cargoes, and for other purposes," approved April 18, 1879, it was made the duty of the National Board of Health to recommend with regard to the form of steam-vessel and refrigerating machinery to be used for this purpose. This was done by a letter to Hon. John Sherman, Secretary of the Treasury, under date June 17, 1879, after having obtained the aid and counsel of a board of experts in naval engineering and ship construction, convened at the request of this board by the courtesy of the Secretary of the Navy. All the documents and correspondence in connection with this subject have been presented to Congress in a letter from the Secretary of the Treasury in reply to a Senate resolution of June 23, 1879, and published as Executive Document No. 33, Senate, Forty-sixth Congress, first session, to which reference is made for further information on this point; and to Executive Document No. 30, Forty-sixth Congress, first session, being a letter from the Secretary of the Navy in reply to Senate resolution, June 17, 1879, and transmitting a copy of the report of the naval engineer officers appointed to examine plans and specifications of refrigerating ship and machinery, reference is made for further information.

It is understood by the board from the annual report of the honorable Secretary of the Treasury that no action has been taken in this matter, and that the whole subject has been referred for additional action by Congress, if such should be deemed expedient.

In this connection the board would respectfully observe that, in its opinion, it is not expedient that the construction of such disinfecting ship should be carried out by contract given to the lowest bidder. If such ship is to be constructed at all, it should be for disinfecting purposes, including not merely apparatus for refrigeration, but also for disinfection by dry heat, by superheated steam, by disinfecting gases or vapors, &c.; it should also have means for disinfecting clothing and bedding. Such a ship must necessarily contain a large amount of machinery entirely new in design and pattern, and of which it is extremely difficult to make any accurate estimate of cost; this is especially the case with regard to the machinery proposed for the ship recommended by the board of naval engineers, which contains much machinery of a kind never before constructed, and which will require special skill and, in all probability, repeated trials for its satisfactory adjustment. It is the opinion of the board that it would be wiser, if the construction of such a ship should be carried on, that it should be done at one of the navy-yards, under the direction of the Secretary of the Navy, and that the gentleman who furnishes the designs and specifications for such ship should be paid a fair amount for such designs and specifications, and also for his supervision of the construction of the vessel.

When such vessel is completed, the operation of her machinery should be fairly tested at some northern port, as, for instance, in the harbor of New York, before being sent to any of the South Atlantic or Gulf ports.

But one case has occurred in which, in the opinion of the board, it was desirable to take action under the provisions of the latter clause of section 3 of the act approved June 2. This case arose from the complaints made by the health authorities of Philadelphia that vessels coming from infected ports were boarded by boarding-house runners from that city, at points outside of the jurisdiction of its quarantine authorities. The board having ascertained by a special inquiry that neither the State of Delaware nor New Jersey could execute and enforce regulations adequate to meet the emergency, reported the facts to the President of the United States, and were authorized by him to carry out the provisions of the law as set forth in said section. Under this order the board framed certain additional rules and regulations, a copy of which is given in No. 10 of the Bulletin, page 84, which were approved by the President August 22, 1879. To carry out these rules, Surgeon J. W. Coles, United States Navy, was detailed by direction of the President. That officer proceeded to Philadelphia to confer with the health authorities of the city, and after consultation reported that in view of the lateness of the season it was not considered desirable to establish this quarantine station or to attempt to carry out the proposed rules and regulations during the present year, which recommendation was approved by the executive committee.

The matter has since been investigated by an officer of the board, who, after conference with the board of health of Philadelphia, and with some of the leading merchants and ship-owners of that city, reported that the danger of the introduction of contagious or infectious diseases at this port by evasion of its quarantine is not at present sufficiently great to warrant the expense to the United States or the hinderance to commerce with such an inspecting station as was proposed by the board would entail, if the quarantine station of Philadelphia is to be continued as at present. The board have therefore advised the President that in its judgment it is expedient to cancel the rules made by it and approved by him relative to this station.

It is believed that hereafter it may be desirable that the United States should establish a complete quarantine station at some point below Newcastle, on the Delaware, which station would remove the necessity for any State or local quarantine higher up the river.

The requirements of the 4th and 5th sections of the act approved June 2, 1879, have been met by the weekly publication of the National Board of Health Bulletin, a complete file of which, to date, accompanies this report. The total number of copies of the Bulletin regularly issued is 4,500.

The duty imposed on the board by section 3 of the act approved July 1, 1879, has not yet been performed, for the reason that Drs. Bemiss and Cochran have been occupied throughout the summer for the board in sanitary and professional work connected with the epidemic, and Colonel Hardee has been employed on the Havana commission; hence these gentlemen have been unable to complete their reports. They will be placed in the hands of the board during the first week in January. In connection with this report, to present it in proper form, it will be necessary to reproduce about a hundred maps of cities and towns, prepared by Colonel Hardee, and also a number of diagrams of the record of temperatures, prepared by Dr. Bemiss. The total cost of the work is estimated as follows at the Government Printing Office:

The estimated cost of 10,000 copies of the report of experts on the yellow-fever epidemic of 1878 is as follows:

Composition	$1,461 60
Presswork	945 00
Folding	422 24
Paper	4,130 49
Binding	1,500 00
Total	8,459 33

The report of Drs. Bemiss, Cochran, ond Colonel Hardee, including the necessary illustrations, will cost about as follows:

Composition	$1,753 92
Presswork	1,125 00
Folding	594 00
Lithographing	4,400 00
Paper	4,937 28
Binding	3,000 00
Total	15,810 20
Grand total	24,269 53

The board submits herewith an account of the expenditures from the date of its organization to December 31, 1879:

Expenditures of the National Board of Health, December 31, 1879.

Furniture	$1,824 08
Employés	11,216 48
Miscellaneous expenses	1,319 09
Rent	875 00
Light and fuel	187 80
Stationery	1,141 75
Pay and expenses of board	7,371 91
Pay and expenses of executive committee	1,439 85
Telegrams	1,389 71
Postage	481 36
Printing Bulletin	2,095 77
Printing blanks, &c	1,700 96
Quarantine expenses, pay and expenses of inspectors	11,797 29
Miscellaneous investigations (act March 3, 1879)	1,772 40
Conference with sanitarians	178 25
Havana Commission	12,314 34
Services of T. S. Taylor (act June 2, 1879)	540 00
Expended in State of Louisiana	13,628 30
Expended in State of Florida	3,006 28
Expended in State of Tennessee	47,742 03
Sanitary survey, Memphis, Tennessee	903 75
Expended in State of Mississippi	13,180 24
Expended in State of Illinois	3,849 77
Expended in District of Columbia	520 00
Expended in State of Arkansas	7,539 51
Expended in State of Texas	115 00
Expended in State of Alabama	150 00
Floating quarantine stations	3,915 15
Ship Island quarantine	1,806 35
Total expenditures	154,002 42

Appended to this is given an estimate of expenditures from January 1 to June 30, 1880, and of expenditures from July 1, 1880, to June 30, 1881.

It will be perceived that to meet these estimates the sum of $90,392.42 should be appropriated for the use of the board in addition to the balance of funds which it has on hand.

In addition to this estimate it is advised that an appropriation of about $100,000 be made, to be held in reserve for the emergency of the occurrence of such an epidemic as that of 1879, and to be used solely for purposes of inland quarantine in case of such an outbreak.

From January 1 *to June* 30, 1880.

For establishment of quarantine stations at mouth of Chesapeake Bay, at Ship Island, and near Brunswick, Ga., or Fernandina, Fla	$100,000

For improvement of quarantine station at Charleston....	$12,000
For aid to other quarantine stations....	48,000
For establishing inspecting stations on the Mississippi and for police boat....	35,000
For special investigations and surveys*	21,500
For printing report on yellow fever (see details above)...	25,000
For printing report of board, with appendices....	8,000
For salaries and traveling expenses of inspectors	10,000
For salaries and traveling expenses of members of the board....	5,000
For rent, light, and fuel....	800
For clerks, messenger, and watchman....	10,530
For stationery	1,500
For postage....	500
For telegrams	500
For printing of Bulletin	2,500
For other printing....	1,500
For contingencies and miscellaneous....	2,000
Total	284,330

* Most of these are now in progress.

From July 1, 1880, *to June* 30, 1881.

For maintenance of quarantine and inspecting stations under immediate control of the board....	$65,000
For aid to State and local quarantines	30,000
For special investigations and sanitary surveys	30,000
For salaries and traveling expenses of inspectors....	20,000
For salaries and traveling expenses of members of the board	10,000
For rent, gas, and fuel	1,700
For clerks and messengers	21,060
For stationery, postage, and telegrams	5,300
For printing of Bulletin	5,000
For printing of annual report	6,000
For other printing....	3,000
For contingent and miscellaneous	5,000
Total	202,060

J. L. CABELL,
President of National Board of Health.
T. J. TURNER,
Secretary of National Board of Health.

2

SUPPLEMENT No. 3,

National Board of Health Bulletin.

Report of the Committee charged with making a sanitary survey of Memphis, Tennessee.

WASHINGTON, D. C., *March* 1, 1880.

At the meeting of the National Board of Health October 13, 1879, it was decided that a sanitary survey of the city of Memphis should be made, and a special committee of the Board, consisting of Drs. J. S. Billings, H. A. Johnson, and R. W. Mitchell, was appointed to take charge of the matter.

This committee was authorized to have made a house-to-house inspection, provided this was agreed to by the authorities of the city, and to employ two experts. It was also directed to visit Memphis at the close of the November meeting of the Board.

On the 21st of October the following resolution was received from the State Board of Health of Tennessee:

"Whereas proper sanitation, having for its object the promotion of the public health as applied to cities, can only be accomplished through the means of a thoroughly systematized and comprehensive plan, and the city of Memphis is now in such a condition as to demand the early adoption of a plan for future operations relating to its permanent sanitation; and

"Whereas the geographical position of Memphis and her relations by commercial intercourse place that city in a situation to imperil, in times of pestilence, the health of the whole Mississippi Valley; and

"Whereas neither the authorities of Memphis nor the board have the means at hand necessary to the accomplishment of this work: Therefore,

"*Be it resolved*, That the co-operation of the National Board of Health be requested for the purpose of making a thorough and complete sanitary survey of the city of Memphis at as early a date as possible, after the close of the present epidemic of yellow fever, with the view of indicating what conditions exist favorable to the production and spread of disease, and what measures should be adopted for their removal, with the methods of their accomplishment and the estimated cost of the same.

"Adopted at the quarterly meeting of the Tennessee State board of health, held October 7 and 8, 1879."

In accordance with a request made by the National Board, Hon. John Johnson, of Memphis, member of the State Board of Health of Tennessee, was designated to represent that body, and to aid and counsel with the committee having charge of the survey.

On the 30th of October a telegram was received from Hon. D. T. Porter, president of the taxing district of Shelby County, asking the National Board to make a complete sanitary survey of the city as soon as practicable, in reply to which he was informed of the action of the Board, and was requested to give such assistance toward making the examination complete and accurate as might be in his power.

At this time yellow fever was still prevailing in the city, and it was useless to undertake any house-to-house inspection or survey at that time, since the great majority of the inhabitants were absent and their houses were closed. The necessary blanks for the house-to-house inspection were, however, prepared after an examination of a number of blank forms of a similar character. The form decided on measures 7 by 9 inches, and is as follows:

No. —. NATIONAL BOARD OF HEALTH. 1879.

SANITARY INSPECTION OF MEMPHIS.

1. Ward ——, street ——, No. —.
2. Owner or owners, ——.
3. Area of lot, ——; of house, ——; out-houses, ——.
4. Age of house, ——; material, ——; No. of stories, ——.
5. Cellars and basement, ——.
6. Rooms and passages, ——,
7. Sinks, drains, and cess-pools, ——,
8. Privies or water-closets, location and condition, ——,
9. Yards, ——.
10. Hogs or other animals, ——; fowls, ——; No., ——; where kept, ——.
11. Public nuisances on or near premises, ——.
12. No. of families in house, ——; names of heads of families, ——; No. of persons in each, specifying No. of whites and blacks, ——.
13. Sickness now in house, ——; what diseases, ——.
14. Any sickness during past year, ——; what diseases, ——; No. of cases, ——.
15. Any deaths during past year, ——; what diseases, ——.
16. Water-supply, sources of, and sources of contamination, ——.
17. Presence of possibly infected material, ——.
18. Sanitary needs and estimated cost, ——.

The above is correct as personally examined by me this —— day of ——, 18--.
Refer to directions often.

—— ——,
Inspector.

Fifty such sheets were put together, forming a memorandum block, on the back of which was printed the following

"DIRECTIONS.

"The figures below refer to the corresponding numbers on the other side. (See above.)

"1 and 2. Give the exact and full name of the owner or owners of the estate. Give the street and number, and describe the location so that it cannot be mistaken.

"3. Give dimensions of sheds, privies, stables, &c., with their relations to living-rooms.

"5. Examine cellars VERY CAREFULLY, and describe their condition, particularly with regard to dampness, amount and kind of filth, ventilation, &c.

"7. Is there any offensive smell from the sinks? Are the pipes or spouts water-tight? Are there any traps to prevent foul air from coming into the rooms? Are the spouts broken, leaky, and filthy? Are the sink-drains clogged or uncovered? Are the cess-pools tightly covered and clean? Do the cess-pools leak into the cellar or into the well?

"8. Privies and vaults: Describe their condition particularly. Are they full or running over? Are they filthy? Is the vault tightly covered? Do they smell badly? Do the vaults need emptying?

"9. Describe particularly the kind and amount of all heaps of filth about the premises, and the general condition of the yards.

"11. Public nuisances, as sewers, stables, offensive manufactories, &c.

"12. Note overcrowding.

"13, 14, 15. Inquire particularly.

"16. State whether, in addition to the supply from water-mains, water is used from a well or cistern; whether it is called good or bad; whether any filth probably drains into the well, &c.

"17. Note bedding, wearing apparel, and upholstered furniture, and whether disinfection has been performed in the house.

"Give any other information and make such suggestions as may occur to you on the back of the form, referring, when necessary, to the numbers. Give all descriptions in as few words as possible, but be clear and definite."

It is considered that this form is more convenient for the purposes of such an inspection as the committee desired to make than any form of memorandum-book to be carried in the pocket. It was found that a very excellent contour map for the greater portion of the city had been prepared by Mr. Charles Hermany, the engineer in charge of the water-works at Louisville, Ky., in connection with a report made by him to the city proposing a system ef sewerage and water supply in the year 1868, and after examination of this map it was not considered necessary to have any further work done in this direction for the purposes of the survey.

As soon as the epidemic had ceased and a majority of the citizens had returned to their homes, the house-to-house inspection was commenced under the immediate direction of Dr. R. W. Mitchell, the resident member of the Board.

At the close of the meeting of the National Board of Health at Nashville, Tenn., November 22, the committee met in Memphis, having associated with it Maj. W. H. H. Benyaurd, United States Engineers, detailed by the War Department as consulting engineer in accordance with the request of the Board; Dr. C. F. Folsom, secretary of the State Board of Health of Massachusetts; George E. Waring, jr., and Dr. Charles Smart, United States Army, who had been specially detailed for the purpose of making analyses of the water supply.

After a general survey of the city and obtaining information and suggestions from the authorities and principal citizens of the place, and after an examination of the results of so much of the house-to-house inspection as was then completed, the committee prepared a preliminary report, and in view of the urgency of the case and the importance of prompt action, furnished a copy of the same, with their recommendations, to Governor Porter, authority to furnish such report having been granted by the board at the Nashville meeting. A copy of this preliminary report is given in No. 24 of the BULLETIN.

The recommendations of the committee were as follows:

First. That measures be at once taken to secure proper superintendence and subsequent care of the sanitary work to be undertaken by the city. This will involve, among other things, the employment of a trained and thoroughly competent sanitary officer, and it is absolutely necessary that such intelligent superintendence and care shall be provided and continued, if good results are to be obtained from any comprehensive system of municipal sanitation. There is a large

amount of sanitary work to be done in Memphis, the details of which must be left, to a great extent, discretionary in order to secure the best results without unnecessary expense; but this discretionary power should be intrusted only to a competent health authority, independent of politics, and, unless it be provided, we do not think that the efforts of the authorities and citizens of Memphis to make it a healthy city will be successful.

Second. That as soon as possible there shall be carried out a methodical and thorough system of opening, ventilating, and chilling all the houses in the city, whether occupied or unoccupied. This should be done in such a manner as to secure the exposure to currents of fresh cold air, for at least twenty-four hours, of all rooms, cellars, closets, interior of trunks, boxes, bureau drawers, &c., and also of bedding, carpets, clothing, &c.

In this connection it is also recommended that all rags, bedding, material for mattresses and articles of a similar nature now collected in the junk-shops of the city, or which may be found elsewhere under circumstances which would cause the presumption of their infection, should be at once collected and destroyed by fire.

Third. That it is important that the city should have control of the water-works, at least to such an extent as to insure a change in the present source of supply, and also to insure that a sufficient amount of water for sanitary purposes shall at all times be at the disposal of the city. The water supply should be taken either from the Mississippi River, above the point of entrance of Wolf River, from a deep-lying, pure water-bearing stratum, if such can be found, or from a distant inland source.

The use of all polluted cisterns and wells should be at once discontinued.

Fourth. That a large number of houses in the city should be condemned, torn down, and the material destroyed by fire. This will include not only foul shanties and cabins, but some large buildings in the heart of the city.

Fifth. That all privy vaults now in the city should be cleaned out and filled with fresh earth, and that hereafter no system of dealing with excrement shall be permitted which involves pollution of soil, water, or air. In those portions of the city so thickly settled as to warrant it, there should be introduced a system of sewerage to discharge into the Mississippi River upon a plan substantially as recommended by Colonel Waring. This plan excludes rain-water and subsoil water from the sewers, and makes use of earthen pipes instead of brick, the dimensions of the pipes being so regulated as to secure a constant flow, which, at the maximum, shall not more than half fill the pipe at any point. The pipes are to be flushed at regular intervals with clean water from the city water supply, by means of a system of flush-tanks. These recommendations include a system of subsoil drainage, discharging into the bayous and into the river.

The total cost of these systems of sewerage and subsoil drainage is estimated at $225,000.

The connection of houses with this system of sewerage should be under municipal control, and in accordance with specifications to be prepared by the sanitary authorities. Public urinals and water-closets to connect with the sewers should be provided. The city should take charge of the removal of excrement from all premises not connected with sewers, and should insure, by frequent and trustworthy inspection, the proper condition of the receptacles so used. In those houses which are to be connected with the sewers, and in which the privy vaults are discontinued, there should be used in the interval between the closing of the vaults and the making connection with the sewers some simple form of frequent dry-earth removal.

Sixth. That the bayous, with a sufficient strip of ground on each side to insure their control and freedom from pollution, should be made the property of the city for securing drainage and as a public park, the banks being properly grassed and a constant stream of clear water being secured. The backing up of high water from the river into the bayou should be prevented by means of a dam, in connection with which must be provided pumping machinery to dispose of the ordinary flow during such period of high water. This pumping would not generally apply to the storm-water falling on the surface of the city, since the plan of surface drainage includes an intercepting surface gutter on each side of the bayou, carrying over the top of the dam the water of all ordinary storms. The total cost of the dam and pumping apparatus is estimated at $3,500.

Seventh. That a system of building regulations shall be enacted and enforced, providing that no buildings shall be hereafter erected in the city unless the plans have been approved by the sanitary authority, and that the construction shall also be subject to its inspection and approval. All uncondemned buildings whose lower floors are less than two feet from the ground should be raised to that height as early as possible; and in future all dwellings should be built with their lower floors at least two feet from the ground; also, that all cellars and basements should be freely ventilated. All this should be enforced by municipal authority.

Eighth. In this brief report no recommendations are made with regard to many important points in municipal sanitation, such as the system of removal of garbage, slop-water, dead animals, and refuse; the regulation of markets and slaughter-houses, hospitals and public charities, public baths, cemeteries, school-houses, &c.—in part because the detailed inspections on these points are not yet completed, in part because these are largely matters of detail, requiring the constant supervision of the competent sanitary authority, urged in our first recommendation; and the providing such authority is the best means of insuring that all these things will receive due attention. The existing regulations requiring the reporting of all cases of contagious and infectious disease, and also the requiring of burial permits, should be strictly enforced.

Ninth. With the exception of those devoted to heavy traffic, it is advised that all streets should be constructed of Paducah gravel, laid on a properly shaped road-bed, after the subsoil drains have been established, and that the gutters and curbs should be made of concrete.

Since the visit of the committee Dr. F. W. Reilly, who had been appointed inspector in charge and assumed the duties of that position November 22, has, in accordance with the instructions of the committee, vigorously pushed the house-to-house inspection, and this was completed early in January.

A copy of Dr. Reilly's report and a summary of the sanitary history of Memphis, Tenn., prepared by him is herewith submitted.

In connection with this there is also submitted a report of Dr. Charles Smart, U. S. A., on the analyses of the water supply of certain towns of Mississippi and Tennessee, and more especially of the city of Memphis. It will be seen from these reports that the report of the results of the inspection of one ward of the city, upon which the committee based the recommendations contained in their preliminary report of November 27, gave a fair sample of the condition of the entire place, and it is not probable that the recommendations of the committee would have been materially different in any respect had they had at that time the entire data which are now presented. As the house-to-house inspection proceeded Dr. Reilly, in accordance with the instructions of the committee, has furnished to the authorities of the city lists of the principal nuisances discovered, giving their precise location and character.

The recommendations contained in the preliminary report of the committee were approved by the executive authorities and by the committee of citizens of Memphis, who petitioned the governor to call a special session of the Legislature to grant to the taxing district the necessary authority to levy a tax to carry out the work thus recommended.

Accordingly the Legislature was called and passed an act authorizing the levying of a tax of two per cent., one-half to be collected in February and one-half in November.

In the mean time the legislative council had passed an ordinance directing the immediate emptying and filling up with fresh earth of all privy vaults in the city. This met with considerable opposition, and the result was that the ordinance was finally modified to read as follows:

"SECTION 1. *Be it ordained by the legislative council,* That so much of the health ordinances, sections 258a to 258e inclusive, p. 1245 (Heiskell's Digest), as require the filling up of all privy vaults, and the carrying away of excrement at the occupant's or owner's expense, be, and the same is hereby, modified, and shall have force as follows: There shall be appointed by this council and the board of health, inspectors of vaults, who shall each at once proceed to inspect every privy vault and water-closet, in the respective districts assigned them, and where in his or their opinion the same, or any of them, are in unsanitary condition, the inspector shall at once condemn the same as a nuisance, and notify the occupant or owner of the premises, where such privy vault or water-closet is, to clean out, disinfect, and fill up the same within ten days thereafter: *Provided, however,* When such occupant or owner is so notified, if he feels aggrieved by such action, he may petition the fire and police commissioners, within two days after said notice, to have a committee of three citizens, to be appointed by the president, to visit and inspect such vault, who shall act at once, and upon their inspection such action shall be taken as they or any two of them may in writing suggest.

"SEC. 2. *Be it further ordained,* That after the privy vaults have been cleaned out, disinfected, and filled up, the fecal matter from receptacles provided therefor shall be removed at the expense of the district until connections can be made with the sewers now in contemplation of construction, or until such time as this council shall further determine; and receptacles shall be furnished by the district to all who choose to accept the same, at the lowest cost price.

"The object of this modification being to more effectually and certainly prevent the pollution of soil, air, or water, and carry out the recommendations of the National Board of Health.

"Passed January 10, 1880.

"D. T. PORTER,
"*President.*

"C. L. PULLEN,
"*Secretary.*"

The plan of sewerage proposed by Colonel Waring was finally adopted by the legislative council, and in the latter part of January contracts were made for sewer-pipe, and Colonel Waring was appointed to superintend the work, which at the present time is going on as fast as the nature of the case will admit. It is hoped that the principal portions of the city will have sewer connections by the 1st of May next. The work of condemning and destroying unsanitary houses, shanties, &c., has been going on in accordance with the neces-

sary legal forms, and over one hundred such houses have been destroyed at the present time.

In addition to those that are to be destroyed there are a large number of houses in Memphis which ought to be raised from the ground, so as to permit the free circulation of air beneath them.

The quantity of dangerously infected material, bedding, clothing, &c., now in the city of Memphis which has not been disinfected is probably small. In a majority of houses in which the disease occurred during the past year articles of infected clothing or bedding were either destroyed or disinfected at the time, and the location of the remainder has been pointed out in detail to the health authorities. The committee have also strongly urged on the authorities from time to time the destruction of collections of rags, of which there are several in junk-shops in Memphis. One of the largest of these collections was burned by an accidental fire in the fall of the year. While it is quite possible that during the cold weather these rags might be baled and sent to paper-mills in the North and be there used with impunity, it is well known that the stock received at paper-mills is often not used for a number of months, and that thus there is certainly at least a possibility of conveying the disease in this way. Irrespective of this, however, it is believed that the general principle of forbidding the exportation of rags of any kind, from a place so dangerously infected as Memphis has been, is one that should be maintained, and that to secure the confidence of neighboring communities all such collections should be forbidden, and if found should be promptly destroyed. It is impossible to secure satisfactory evidence that the whole of any given quantity of rags has been properly disinfected, and the value of such collections is not sufficient to warrant attempts at their preservation.

Owing to the delays in obtaining the necessary authority from the Legislature deciding upon the plan for sewerage, making the necessary contracts, &c., it will be impossible to commence the work of laying the sewers at the point where it is desirable that this should be done, viz, at the lowest point on the level opening into the river, since the river is now many feet above low-water mark, and extensive back-water is caused in the Bayou Gayoso. To avoid the difficulty which this would cause it is proposed temporarily to turn the sewage into a large iron pipe at present used for carrying the sewage from the prison into the river.

It is hoped that much will be done before the approach of warm weather in the way of destruction of infected material and houses, of cleaning and filling the worst of the privy vaults, in establishing a system of sewerage, and to some extent a system of drainage throughout the city. Very little, however, can be done during the present season to remedy the evils of the present water supply. The difficulty and cost of extending by means of inverted siphons the supply pipe for the present water-works across the Wolf and Hatchie Rivers to the Mississippi River is so great that the parties now having control of the water-works will not attempt it. The majority of the cisterns in the town contain water which is unfit for use, at least without boiling; and the water from the Wolf River is unfit for use without careful filtration, by means of filters which should be very frequently renewed.

The report of Dr. Reilly, and especially the statistics of the mortality of the city, with his remarks thereon, furnish additional proof, if any were needed, as to the unsanitary conditions which have prevailed.

The following communication was addressed to President D. T. Porter, under date of February 16, 1880:

"DEAR SIR: I have the honor to invite your attention to the fact that it will be prudent for the municipal authorities of Memphis to keep in view the possibility of the reappearance of yellow fever in that city as warm weather comes on, somewhat as the disease appeared last year. While we have good reason to hope that the sanitary measures which have been inaugurated, and are now being urged, by the city may have the effect to free the place of local causes of this disease, it is still impossible at the present time to say with certainty that this will be completely effected. This uncertainty increases the responsibility of those officially charged with the interests of the city, and makes it imperative that the powers conferred and the duties imposed upon them by law be utilized and discharged to the fullest extent.

"In view of the great desirability of taking every precaution to prevent the recurrence of an epidemic during the coming year, I would respectfully offer the following suggestions, premising that I do this with a full appreciation of the difficulties and drawbacks under which the officers of the taxing district have heretofore labored, but which it is presumed are now in the main removed by the decision affirming the constitutionality of the district government.

"Sections 158 and 259 of article 1, chapter 5, of the ordinances of Shelby County, Tennessee (see pp. 97 and 125–6 of Heiskell's Digest, Memphis, 1879), confer upon the board of health the authority to make, establish, and declare all rules, orders, special regulations, and sanitary ordinances necessary for carrying into effect the provisions and powers contained in said article. And the latter section (259) declares the neglect or violation of any such rules, orders, sanitary regulations or ordinances, to be a misdemeanor, punishable by fine on trial and conviction.

"Under this authority it is clearly the duty of the board of health, as it is certainly of the utmost importance, to "declare," by publication in the columns of the daily papers, by circular, and by other, usual methods, the duties and responsibilities of the various classes of the community, professional and secular, with reference to the public health. It is idle to expect that any large number, even of physicians or other intelligent members of the community, will make such study of the ordinances as is necessary to define their duties and responsibilities; but it may be safely asserted that if the requirements were understood they would receive prompt and willing compliance from the large majority of all classes. As early notification of the existence of contagious disease is of the first importance at all times, but more especially at present, I would suggest that the regulations of the board for the enforcement of section 236 (see Digest, p. 118), requiring "every physician to report to the board of health in writing every person having a contagious disease," &c., set forth that it shall be held to be a substantial compliance with this section if the physician furnish to the householder or head of the family in which a contagious case may be a written certificate containing the information called for in said section. Regulations, based on section 240 (*ibid.*, p. 119), should then make it a substantial compliance with the requirements of this latter section if the householder or head of the family promptly deliver said certificate to the secretary of the board of health, but in default of the attendance of a physician should still enforce a literal compliance with the section.

"In this, as in all other regulations of the board, the penalties as prescribed in section 259 (*ibid.*, pp. 125–6) should apply to failure of either party, and should be clearly specified and strictly enforced. My reason for making this suggestion is that it is for the benefit of the householders of the city of Memphis, and not for the benefit of physicians, that such reports should be made, and I do not think it just or good policy to undertake to compel physicians to make such reports without giving them adequate compensation. As a matter of fact, all physicians do not make such reports, and at no place in this country has it been found possible to literally enforce such a law. Another reason is the fact, to which I shall again allude, that among the negroes a physician is by no means always called in in case of yellow fever.

"The enforcement of section 240, in the manner indicated, would, however, tend to secure reports even in such cases.

"Like action is suggested with reference to the following sections, if it be true, as I am informed, that these sections are ignored.

"Section 154 (*ibid.*, p. 96), requiring physicians, midwives, and others practicing about the cure of the sick or injured, to be properly registered at the board of health.

"Section 237 (*ibid.*, p. 118), requiring reports of deaths from contagious or infectious diseases within twenty-four hours after their occurrence. (I am informed that under the existing practice a death from a contagious disease might occur on Sunday morning and the board of health would have no official cognizance thereof until the following Saturday evening.)

"Section 251 (*ibid.*, p. 122), forbidding the retention or exposure (as in public funerals of decedents from contagious diseases) of dead bodies to the peril or prejudice of the life or health of others.

"Sections 252, 253 (*ibid.*, p. 122), requiring reports of births, marriages, and deaths.

"In such regulations and orders as the board may profitably publish at the present time concerning the foregoing, it is very desirable to charge those immediately interested, namely, the householder or head of the family, with the duty of communicating directly with the board, as has been already indicated. Wherever the phrase "contagious disease" occurs in any quoted section of the ordinances, or in circulars, orders, &c., its definition as given in section 154 (cholera, yellow fever, or scarlet fever) should also be set forth, or so much of it as may be necessary to keep clearly before the public mind the object of the requirements. In addition to the necessary declaration of regulations for the enforcement of the above-named sections, and whose prompt publication I cannot too strongly urge, I think that great benefit would accrue from a circular or card of instructions (which, of course, should have the force of a regulation of the board) to the various classes of persons mentioned in sections 238, 239, 241, 242, 243, and 244. Such circulars or cards should be furnished the proper persons, and required to be preserved and conspicuously displayed in, for example, the cabins of all steamboats, in all railroad baggage, express, and passenger coaches or cars, and at railway stations of roads centering in Memphis; in the offices and all rooms of hotels, inns, boarding and lodging houses, &c. It will be understood that such action as is hereby suggested must be continuous; that orders and regulations will need repeating and explaining, possibly modifying, from time to time, according to circumstances and developments. In sanitary matters the educational process is never-ending; new scholars need the old lessons, but the results are much more creditable and cost vastly less than the most scientific and efficient efforts that can be possibly made in dealing with an epidemic after it has been allowed to begin.

"Aside from these suggestions of methods for the discharge of duties made obligatory by statute, I have also to urge—

"Secondly. That measures be taken to secure, as far as possible, reliable information with regard to the health of the colored popula-

[illegible]

[illegible]

Respectfully, your obedient servant,

Your Committee. J. S. BILLINGS, M. D., Chairman.

Documents accompanying the report of the committee of the [illegible] sanitary survey of Memphis.

A.

REPORT OF DR. F. W. REILLY.

SIR: In pursuance of instructions [illegible] the sanitary survey of Memphis [illegible] charge of the [illegible] on the following [illegible], November 26 [illegible] preliminary work had already been [illegible]

[illegible]

[illegible] the total number amounted to [illegible] houses.

The office work embraced, in addition to the tabulation of the inspection returns and the current clerical routine duties, the preparation of [illegible] special reports on the public schools, the river front, condition of the [illegible], condemnation of buildings, infected [illegible], garbage removal, &c., which were submitted from time to time to the local authorities through the resident member of the committee, Dr. R. W. Mitchell, National Board of Health.

A schedule of the conditions requiring attention from the local authorities was also compiled for each ward as soon as its inspection was completed, and this was transmitted through the same channel to the authorities of the Taxing District. Ten of these schedules were thus prepared, covering [illegible] pages of [illegible] in six columns, and setting forth the location and description of [illegible] insanitary conditions of all grades.

[illegible] volumes of inspection returns, covering [illegible] inspections, have been paginated, indexed, and arranged by wards in such a manner as to make instant reference to the original inspection of any locality possible. The tabulation of the returns has been [illegible] in [illegible] volumes, containing [illegible] different entries. In these sheets [illegible] every structure and [illegible] of ground within the corporate limits of Memphis is succinctly described, with its sanitary condition at the date of inspection.

Data have also been furnished from the office to Major [illegible], United States Engineer, upon which has been compiled a map showing the [illegible] area and estimated value of the property abutting upon the bayou. This is intended to further the plan for the [illegible] recommended by the committee on the sanitary survey.

A [illegible] map [illegible] condemned buildings, [illegible] vaults, [illegible] water supply [illegible] nuisances has also been prepared, and such a map of the entire city is now being completed. These [illegible] so designated that ready reference may be made to the original inspection return for a full description of any individual [illegible].

[illegible] progress of the work, the following gentlemen have been engaged as inspectors in the employ of the National Board of Health:

Dr. [illegible], Memphis, from November 7 to December 31.

Dr. [illegible], Memphis, from November 7; still on duty.

Dr. H. Lee, Memphis, from November 7 to November 24.

Dr. [illegible], New Orleans, from November [illegible] to December 31.

Dr. [illegible], Memphis, from November 24 to December 15.

Dr. [illegible] W. [illegible], New Orleans, from November [illegible] to December 31.

Dr. W. [illegible], Memphis, from November 7 to December 31.

[illegible] the letter is a general outline of the sanitary history of the city, based in great part upon the results of the house-to-house inspection, and covering, it is believed, most of the topics of general interest.

I am, sir, very respectfully, your obedient servant,

F. W. REILLY, M. D.,
Inspector-in-Charge.

JOHN S. BILLINGS, M. D., U. S. A.,
Chairman Committee on Sanitary Survey of Memphis.

Summary sanitary history of Memphis, Tenn., based upon a house-to-house inspection of the city, November 24, 1879, to January 3, 1880, made under the direction of the National Board of Health.

The city of Memphis, at present the "taxing district of Shelby County," is situated in Shelby County, Tennessee, latitude 35° 7′ north, longitude 90° 7′ west, with a greatest altitude of 287.44 feet above tide-water in the Gulf of Mexico.

As early as 1682 the site of the present city was occupied as a trading post, by the French under La Salle, who made a treaty with the Indians of the Chickasaw tribe, and built a fort upon the bluff, which bears their name. In 1783 the region was taken possession of by the Spanish governor-general of Louisiana, Don Gayoso, whose name is also perpetuated in the bayou running through the city. Gayoso fortified the post at the then mouth of the Wolf River, about where the foot of Jefferson street now is, and the Spanish occupation continued until the treaty of San Ildefonso, in 1803.

The original purchase of the five thousand acres in which the site is included was made in 1783, by John Rice, a merchant who removed from North Carolina to Nashville about this period. In 1794 Judge John Overton became the owner of the tract and conveyed a half interest in the property to General Andrew Jackson, who in turn sold three-fourths of his interest to James and William Winchester in the year 1819. In the following year, 1820, the town was planned, and called Memphis. At this time the settlement numbered fifty-three souls. In 1826 the town, with a population of between five and six hundred, was incorporated; but, owing to local rivalries, two corporations, the "city of Memphis" and the "city of South Memphis," were erected under the charter, and so continued until 1852, when they united in the election of one mayor and one board of aldermen.

POPULATION AND GROWTH.

At this time the population was estimated at less than 10,000, a rapid advance being claimed for the two subsequent years, so that in 1854 a census showed 12,867 inhabitants, which was increased by the close of 1857 to an estimated population of 25,000, this rapid growth being attributed to the completion of the first portion of the Memphis and Charleston Railroad. Although there was a large increase between 1850 and 1860, this latter estimate was not borne out by the figures of the eighth United States census, which gave Memphis a population in 1860 of 22,621, as against 8,841 in 1850, by the same authority. The ninth census (1870) placed the population at 40,226; but it is important to note, in this connection, that the city limits were materially enlarged in 1867–'68, so much so that they embraced 4,114 acres at the time when the ninth census was taken; and much of this additional area was as thickly settled as the average of the former or present area. During the session of the State legislature of 1871 and 1872 another change was made, and the area was reduced to the present city limits, a reduction which cut off 37+ per cent. of territory and 39+ per cent. of population. This would make the population of 1870, contained within the area of the present city limits, 24,253, and it is this figure, and not 40,226, which should be taken in any estimate of the growth of the city within the past decade.

PRESENT POPULATION.

On the 1st of January, 1880, the population of Memphis, as shown by the house-to-house inspection returns, is 30,659, showing an increase of nearly 26.4 per cent. since 1870. Of these there are 16,705 whites in 3,775 families, an average of 4.42 persons to each family, and 13,954 colored in 3,609 families an average of 3.87 persons to each family—a mean average of 4.15 persons to the aggregate of 7,384 families. These occupy 5,584 of the 6,386 dwellings accounted for, giving an average of 5.49 persons to each occupied dwelling. In 1870 there were 5.14 persons to each family (white and colored not separated), and 6.28 persons to each dwelling. The reduced average of occupants to dwellings is readily enough accounted for by the large number of buildings erected during the decade—an increase equal to nearly 54 per cent., while the increase of population is, as above shown, less than 27 per cent. An explanationof the reduction in the number of persons to a family is more difficult, and is complicated with questions involving a study of the epidemics of 1873, 1878, and 1879, of the changed social status of the colored people, and other factors, not, probably, beyond the scope of a "sanitary survey," but for which no opportunity has yet offered.[1]

[1] This percentage of reduction of population is reached by the following process:

Within the city limits of 1870 there were 6,408 dwellings, with an average of nearly 6.28 persons (6.2774+) to each. There are in the present city limits 6,386 dwellings, of which number 2,524 are returned as ten years and under. Deducting these latter from the total present number leaves 3,862 dwellings, which in 1870 were within the present city limits, and as a consequence 2,546 in the area since cut off. Multiplying these 3,862 by 6.28, the average number of persons in each dwelling at that time, gives 24,253 as the figure of population with which to compare the present population. The exact figures would be 3,862 × 6.2774 = 24,243.31 population in 1870 within area of present city limits; and 2,546 × 6.2774 = 15,982.26 population in area cut off in 1871–'72.

If it be sought to compare the population of 1870 (40,226) with that of 1880, it will be necessary to assume the same ratio of increase for the area cut off in 1871–'72 as is known to have been made within the present city limits. This is 26.4 per cent., and would give a total present population of 50,485 within the same area as that occupied, according to the ninth census, by 40,226 persons in 1870.

AREA AND TOPOGRAPHY.

An area of 2,590 acres is embraced within the present city limits, the outlines of which approximate the figure of a truncated right-angled triangle (or trapezoid), the truncated extremity (8,175 feet) being the northern boundary; the perpendicular (13,050 feet) the east boundary; the base (11,625 feet) the southern boundary; while the hypothenuse (17,000 feet) is the water frontage on the Mississippi River.[2]

The site of Memphis and the country immediately surrounding it is the Fourth Chickasaw Bluff, a Loess formation, consisting of a fine siliceous loam, of a rich chrome yellow or buff color. This is superimposed upon a varicolored stratum of sands and gravel, locally known as the "orange sand," a southern extension of the drift formation, and immediately beneath which is found the La Grange group of clays and sands of the Tertiary period. The "orange sand" stratum is nearly horizontal, so that it is reached at varying depths according to the thickness of the loam above it.

The bluff formation is well defined along the southern half or two-thirds of the river front of the city, where it presents a bold, almost perpendicular western face, cut through by street openings to the levee. Its greatest elevation is in the southwestern section (on Tennessee street, near the corner of Talbot), where it rises to a height of 67.9 feet above the highest water mark, that of 1867. From this point, along the river front, it gradually descends toward the north, until it is lost in the valley of Bayou Gayoso, some 1,500 feet south of the north boundary. Toward the south the inclination is much less, so that at the south boundary near the river, the highest bluff level is still 57 feet above high water. North of Bayou Gayoso the bluff again rises, but recedes from the river at a much greater angle. Extending back (east) from the river the surface is undulating, with the long axes of the swells and depressions in general north and south lines, except in the northern portion ("Chelsea," "Scotland," and the upper part of "The Pinch"), where the long axes run nearly east and west.

NATURAL DRAINAGE SYSTEM.

Through the depressions flow a series of bayous which form the natural drains of the area, only a narrow strip along the river front draining into the Mississippi River, except in the extreme northwestern portion of the city. Of these bayous, the Gayoso and Quimby are the most important. Bayou Gayoso (with its east and west forks, and its tributaries, the Little Betty and De Soto) drains the southern and central divisions of the city, and flows in a general northerly direction until it receives Bayou Quimby with the drainage of the northern division, when it pursues a northwest and west course, emptying into the Wolf River at a point about 2,500 feet above the junction of the latter stream with the Mississippi.

This natural drainage, flowing mainly from south to north, is still further supplemented by minor undulations running at nearly right angles with the above. As the original conformation of the site has not been materially changed, these undulations afford lateral drainage communicating with the main system, and, with the exception of the localities to be hereafter specified, this surface drainage is ample, even for the heaviest rainfalls.

The average width of the bayous within the city limits varies from ten to twenty-five feet, measured at about mid-height of the banks, and the volume of water varies with the rainfall and stage of water in the Mississippi.

There are but few springs emptying into the bayous, so that their

[2] In order to arrive at the percentage of error in these figures—both that of the "personal equation" and that due to the movement of population—an experimental census of 5 per cent. of dwellings was taken on January 14, 1880. This was done by assigning to each of four men a certain number of dwellings in each ward, the number being distributed pro rata to the total number in each ward. The houses were not designated in advance, but their selection was left to the discretion of the men, care only being taken that the houses should represent all portions of the ward. When these returns were brought in they were entered upon sheets, the first column of which contained the location by street and number of each house visited; the next two columns gave the numbers of white and colored occupants, respectively, found in each house on the 14th of January. The totals of these latter columns were then footed up, and, lastly, the original inspection returns of these same houses were consulted, and in the two remaining columns the numbers of white and colored occupants during November and December were entered. On footing up these columns there was found a difference of only *two* between the total occupants of the same houses on January 14 and in November and December. That is to say, in 286 occupied dwellings taken at random on January 14, there were found 1,533 persons; on comparison, these dwellings were found to have had returned, by a different set of inspectors during the previous November and December, a total of 1,535 persons.

This striking coincidence need not, however, be accepted as conclusive of the accuracy of the grand total, since an analysis of the returns by wards shows a much greater movement than is here indicated. Thus in the fourth ward, which is the hotel and business center, there was a gain of 36 whites and 2 colored, while in the first and sixth wards—frequented by rivermen—there was a loss of 30 colored, the total movement showing a gain of 38 white persons and a loss of 40 colored. This was exactly the reverse of the anticipated result. It was believed that a considerable number of colored people properly belonging to Memphis were absent in the cotton-fields in November and December; that these would return about the holiday season, and thus increase the proportion of colored in the experimental census. On the other hand it had been asserted that many white refugees who returned in November and December had wound up their business and affairs in the city and removed permanently to other places; a decrease in the proportion of the white population was therefore looked for in January. Under the circumstances, the adoption of any given percentage of error in the house-to-house census must be purely a matter of individual opinion, since none is revealed by the experimental census.

contained water is mainly made up of the surface drainage, and of what is locally known as "sipe" water—water which has penetrated below the surface, and gradually oozed out through the banks of the bayous. During high water in the Mississippi, the river water enters the bayous and "backs up" the contents of the latter, this "backing up" having been known to extend for over a mile through the most densely settled parts of the city, and leaving behind it, in the bed of the lower part of the bayou, accumulations of mud or silt of five or six feet in depth. As the stage of water in the river is high enough to obstruct the bayou for four or five months in the year, the current is sufficiently retarded during that period to allow of a large deposit of organic matter upon the banks of the bayous, which rapidly decomposes and becomes offensive as the water falls and exposes it to the action of sun and air. In addition to this source of pollution, there are a large number of privies, built directly over the bayous or upon their banks, the contents of which are discharged directly into the waters, while the surface and sipe water, for a distance of several hundred feet in many localities, is also contaminated with fecal filth from surface privies, overflowing and leaky vaults, &c. A five-foot sewer, which gathers the surface drainage of an area of some 140 acres, on which is the city hospital, and several small private sewers also contribute their quota to the fouling of Bayou Gayoso.

Including the city, an area of upward of 5,000 acres is drained by the bayou system; the total length of Bayou Gayoso, from Wolf River to its head, being five and a half miles, with an inclination of 1 foot in 180 in the city limits; the total length of Bayou Quimby, from its junction with Bayou Gayoso to its head, is a little less than four and a half miles, with an inclination of about 1 foot in 140; and the total length of Bayou De Soto, from its junction with Bayou Gayoso to its head, is two and four-fifths miles, with a slightly greater inclination than that of Bayou Quimby.

RIVERS—THE WOLF AND MISSISSIPPI.

Wolf River enters the city in the extreme northwestern section, constituting practically, its northwestern boundary for an extent of about 4,000 feet.[3] It is an exceedingly tortuous stream, flowing through cypress swamps and cane-brakes for about 65 miles, and receives the Loosa Hatchie River just at the northern boundary of the city. Like the bayous, it is "backed up" when the Mississippi rises more than 15 feet above low-water mark, and it is asserted that at such times the foul waters of the bayou also enter and pollute it. A tannery and a group of slaughter-houses, located about 300 yards below the water-works, discharge blood, offal, and refuse into the stream through a small "run," upon whose banks they are built. It is also stated that when this "backing up" occurs such material is necessarily carried up to the pumps. Aside from its malarial influence, derived from the "bottom" lands through which it flows, the chief sanitary importance of the Wolf consists in its being, to a large extent, the source of the water supply of the city as above intimated. Its waters have been analyzed by Assistant Surgeon Smart, United States Army, and detailed information concerning it will be found in his report upon the water supply of Memphis.

It should be added, however, that personal observation does not confirm the statements made as to the pollution of the water supply by the "backing up" of the bayou and river. With a stage of about 21 feet of water in the Mississippi, and while the bayou was still "backed up," a decided outer current was found in the Wolf opposite the water-works. It is obvious that any rise in the Mississippi sufficient to dam up the waters of Wolf River would also dam up the contents of the bayous and of the "run" above alluded to; and that as the water falls the outward current in the Wolf will be re-established, carrying out with it the retained contents of the bayous and "run." The contents of these latter can only be carried up Wolf River to the water-works when to a suitable stage of water in the Mississippi shall be added a local rain (confined to the watershed of the bayous) heavy enough to swell the volume of water discharged by the bayou beyond the volume of water contained in the Wolf, and sufficiently greater to overcome the fall in the latter stream from the water-works to the mouth of the bayou. Remote as such a coincidence would seem to be, it is stated to have occurred twice within the past ten years. There is, however, reason for believing, from personal observation, that the surface water of the Wolf may be carried up stream for a considerable distance, even when the deeper water is flowing out. Whether this ever occurs to such an extent as to carry the foul waters of the bayou and "run" up to the pumps it is not presumed to assert.

The extreme range between high and low water in the Mississippi at Memphis is about 35 feet, and a gradually shelving shore of varying extent is thus alternately covered and exposed. At the date of inspection, December 16, 1879, with a stage of 19 feet 10 inches above low-water mark, this shore had a greatest width of 258 feet from the foot of the bluff at Jefferson street. Extending north from Jefferson street to the mouth of Wolf River (2,687 feet measured from center of Jefferson to center of Jackson street, along the line of Front Row) the water covered this sloping shore, to the foot of the bluff, with the exceptions noted in the reports of a special inspection of the river front (*q. v.*). Extending south from Jefferson street the bluff has been cut away so as to increase the depth of the shore, and this space, known as "the levee," had a varying exposure of from 150 to 260 feet between the water's edge and the foot of the bluff until the line of Beale street was reached (nearly the same distance as that described above). At Beale street the water again came up to the foot of the bluff, but from this point south to the city limits there was an irregular width of from 20 to 200 feet.

THE WATER FRONT.

These three divisions of the river front present strongly marked contrasts. The northern one, beginning at Wolf River, has a low flat area of about four acres ("Happy Hollow") partially submerged during high water, and receiving a considerable portion of the filthy surface drainage of the northern end of the "Pinch," one of the most objectionable quarters of the city, as well as the polluted discharge from the bayous. The bank is sandy and easily washed, so that mattress protection is necessary. From Market street south to Jefferson the bluffs gradually rise, varying in height from 4 to 25 feet, and along this extent are gullies, "wash-outs," deposits of fecal filth, the outlets of box-drains and culverts, and the accumulations of a public "dump," including everything offensive, from street sweepings to the contents of privy vaults, which, up to May, 1879, were carted to the crest of the bluff at the foot of Washington street, and thence allowed to find their own way to the river. The central division consists of the "levee," so called, an improved area paved with stone, clean and in good condition, with the exception of such nuisances as arise from the want of public latrines for the use of the roustabouts, stevedores, rivermen, &c. As the river falls after high water a deposit of mud covers the "levee," but this is washed from the well-paved and steep slope by the first rain. The southern division reproduces many of the evils of the northern one, aggravated by the location of the present public "dump-boat" at the foot of Beale street, a decided nuisance at this date.

The details of the conditions above generalized are embraced in the special report previously alluded to, the substance of which was conveyed to the proper authorities through the committee on the sanitary survey on the 18th of December, 1879, supplementing previous reports on some of the conditions which had been already submitted on November 10 and December 13.

SEWERAGE.

There is practically no sewer system in Memphis, the four and a half miles of existing private sewers having only 215 connections in all. And while the natural facilities for surface drainage are ample they have not only not been fully utilized or preserved, but in many instances they have been materially impaired, and in some entirely destroyed, by changes in the original conformation or by the character of the street conservancy. With an extremely retentive soil this obstruction of natural drainage renders unpaved streets and alleys almost impassable during wet weather, and readily accounts for the large proportion of damp or wet cellars and basements. These causes—namely, the absence of sewers and of subsoil drains and the obstructed surface drainage—also affect unfavorably the areas of "made land," although these are not numerous or extensive. (Such areas are described in the summary description of the wards.)

STREETS AND ALLEYS.

There are 67 miles of streets and 35 miles of alleys within the city limits. West of the bayou these run nearly with the cardinal points of the compass, the variation being a little east of north and south of east. In the northeastern section this variation is more decided, but in the central and southern sections the same general lines are preserved on both sides the bayou. Details as to width, paving, and condition of streets, alleys, and sidewalks will be found in the ward summaries.

STREET CLEANING AND GARBAGE REMOVAL.

An ordinance requires tenants to clean the gutters and sweep streets and alleys, bounding their premises, for a space of four feet from curbstone, and to pile up the cleansings in the center of street or alley for the garbage carts—this to be done twice a week, the days for each ward or street to be designated by the board of health. The city engineer is empowered to have such work done for delinquents and non-residents at their proper cost; and street railroads and other railroads are required to clean the roadway between, and for two feet on each side, their tracks. Street crossings and intersections are supposed to be kept clean, and street-sweepings to be removed, by the city.

At the date of this report the equipment for garbage removal and street cleaning consists of 2 open wagons, 44 cubic feet capacity; 4 open "Roosa" carts, 32 cubic feet capacity—these for the removal of ashes, street-sweepings, &c.; 2 Louisville air-tight wagons, 52 cubic feet capacity; 1 "Roosa" air-tight cart, 32 cubic feet capacity—these for the removal of wet garbage, &c.; and 16 men and 13 mules.

Theoretically these are supposed to remove six loads each per day—equal to 1344 cubic feet of dry, and 816 cubic feet of wet garbage—an average distance, including trips both ways, of one and one-half miles to the "dump" at foot of Beale street; and, also in theory, this is supposed to cover sixty-seven miles of streets and thirty-five miles of alleys, once each week.

[3] In the northwestern portion of the city a section of low alluvial land about 300 acres in extent is separated from the first and ninth wards by the Wolf River. This is subject to overflow during high water, is partly cultivated in cotton, has one white and twelve or fourteen colored families (who are obliged to vacate during high water), and possesses no features of sanitary interest apart from those which characterize the Mississippi "bottom" generally.

Practically the area west of the bayou, south of Auction street and north of Calhoun street—about two miles long by half a mile wide, and comprising the larger part of the first, all of the second, third, and fourth wards, and much of the sixth ward—is fairly well covered once a week by this force. Much complaint, however, is made of neglect, even in this limited region, and no pretense is made of going into the unpaved streets and alleys in wet weather—in fact, it would be hardly possible to do so. At long intervals, in response to urgent demands, a cart is sent into "Chelsea" (ninth ward); but the fifth, seventh, eighth, and tenth wards, *i. e.*, the region east of the bayou, are substantially ignored, and garbage is here disposed of in every conceivable way—thrown on vacant lots, in alleys in rear of premises, in yards, in disused cisterns and wells, in abandoned privy vaults and gullies, and on the banks of the bayous.

Instead of an average of 54 loads per day being gathered and disposed of (as is believed and stated by the health officer), inquiry at the "dump" and an examination of the dump keeper's book for a recent period of ten days show an average of 29.2 loads per day—a little more than half the theoretical capacity of the force and equipment. The health officer thinks he should have his force increased at least one-third to thoroughly and promptly remove the garbage from the area west of the bayou, and is unwilling to make an estimate of the force necessary to cover the rest of the city.

No marked or radical improvement is to be looked for in this direction until roadways practicable at all seasons are provided; but much relief might be secured (1) by taking advantage of favorable weather, during which the force should be temporarily increased to the necessary capacity; and (2) by vigorously enforcing the ordinance above referred to, such enforcement to be pushed *pari passu* with the capacity for prompt removal.

BUILDINGS—MATERIAL, AGE, AND CHARACTER.

Of the 7,202 buildings of all kinds (this is exclusive of out-houses) within the city limits, 72 per cent. are of wood, 27 per cent. of brick, and the remainder of stone (13) and iron (1). In the strictly residence portions of the city—in fact, in all but the third and fourth wards—the large majority of the buildings are of one story, there being (with the exceptions above noted) 4,188 dwellings of one story, as against 2,198 of two or more stories. Many of the structures returned as "occupied dwellings" are, in effect, the cabins of one or two rooms which, prior to 1861–'62, constituted the slave-servants' quarters. Of these (one or two roomed dwellings) there are 1,209 returned; and this item is of consequence in connection with the remarks which follow concerning the condemnation of buildings.

About 10 per cent. of the total number of all building have been erected within the past five years, and nearly one-fourth of the total number were erected between 1870 and 1875. These buildings, 2,524 in number, embrace the large majority of the really healthy habitations, and substantial, well-ventilated, and properly lighted business blocks. A large number of buildings erected between 1865 and 1870 are mere shells, with thin, insecure walls, flimsy and badly fitting wood-work, and inadequate ventilation and lighting. There are few exceptions to the indictment of this class. Of the remainder (about 40 per cent. of the total number), the ages range from fifteen to fifty years, and there are few of these which do not require radical alterations in order to justify their retention for occupancy.

One of the most important defects noticeable in dwellings is the want of subventilation, 1,453 dwellings being built so close to the ground as to have no air-space beneath the floor; 2,030 others have insufficient or obstructed subventilation; and only 2,204 (about two-fifths of the total number) comply with the proper requirements in this respect.

CELLARS AND BASEMENTS.

There are 1,515 buildings with cellars and basements, and of these over one-half (786) are badly ventilated, damp, or wet, many with water standing from 2 to 18 inches deep on the floors, and with walls soaked by sipage from the surrounding polluted soil. As very few of these cellars are more than 9 feet deep—fully one-half being between 7 and 8 feet, and about one-fourth being less than 7 feet deep—any general system of sewerage and subsoil drainage will remedy this latter defect.

In the two principal business wards of the city (the third and fourth) more than one-third of the buildings were found to have privy vaults in cellars or basements. Many of these buildings are upward of twenty years old, and the cellars contain from one to five vaults each, the accumulations of an average of a quarter of a century being imperfectly covered over with ashes or earth. Not infrequently the rain-water cistern, from which water for all purposes is used, was found surrounded by these vaults with the walls almost touching each other. A few instances are to be found in every part of the city; but the majority are grouped where they are likely to do the most harm—in the densely built and oldest regions.

Among the minor subterranean defects found were 426 cellars and basements fouled by accumulations of decomposing organic matter, infected material, &c. (The past tense is here used advisedly, since much of this has been already remedied through the efforts of the board of health, which has caused most of these cellars to be cleansed and whitewashed and the vaults emptied, disinfected, and filled up.)

CONDEMNATION OF BUILDINGS.

In condemning premises as unfit for occupancy, as well as in recommending buildings for destruction, the basis has been, in all cases, purely and simply with reference to their sanitary condition. Neither weather-beaten looks, intrinsic value, wishes of neighbors, nor unverifiable reputation has been given any weight in arriving at a judgment on these points. This explanation is thought to be pertinent in view of the fact that many buildings have recently been condemned for destruction by the local authorities which are not included in that category in the house-to-house inspection. It is not meant to imply by this that the action of the local authorities has been, or is likely to be, too sweeping, or that their action has been based, in any instance, on insufficient grounds. At best only a proportion, greater or less, of the unhealthy habitations will be vacated or destroyed; but it was believed any recommendations to this effect having the authority of the National Board should be supported by the clearest and most positive proofs, and that all doubtful cases might be safely left with those who, from their official positions and local knowledge and influence, are best entitled to exercise a discretion which must entail serious responsibility in questions other than those of a strictly sanitary character.

On the basis above set forth a total of 494 buildings and groups of structures have been recommended for destruction or for vacation pending alterations necessary to fit them for occupancy. These include not only many cheap, almost worthless, one-story shanties, with one or two rooms, but some brick business blocks, hotels, and public buildings. As an earnest, full of promise for the future of Memphis, it may be noted that the property value of the building has proved no obstacle to the acceptance of the verdict of condemnation; indeed, as a rule, the most prompt compliance has been met with from the owners of the most valuable property. More reluctance, if not positive opposition, may be anticipated from the owners of the numerous "shanties" in disreputable localities, and which rent for two or three dollars a month to the most squalid, filthy, and degraded whites and blacks.

There are few "tenement houses" in the strict sense of that term as applied in large cities, and very few cases of overcrowding have been discovered. Of the 5,584 occupied dwellings 4,365 contain one family each, 905 contain two each, and 314 shelter three or more families in each, leaving still at the date of inspection 802 unoccupied buildings. Many of these (unoccupied) are included in the list of condemned, but a sufficient number of habitable dwellings would still be left in which to house all those displaced from buildings recommended for vacation or destruction.

SOIL AND WATER POLLUTION.

So much has been written and said, *ad nauseam*, of the privy system of Memphis that it is proposed to dismiss it here in a very summary manner, and this the more justifiably, since there is a strong probability of its soon being numbered among the things of the past. At the date of inspection there were found nearly 6,000 sub-surface vaults in use. These varied from mere shallow pits, without any lining, to brick vaults of 40 feet (and upward) in depth. Considerably less than one-third were sufficiently remote from living-rooms, while the remainder were placed at all degrees of proximity, even to being, as already stated, grouped in cellars. Of the total number, 3,607 were in a foul condition. The extent of the soil pollution from this source may be the better inferred when it is understood that the above figures do not include a large (probably equal) number of disused, but unemptied, vaults, the contents of which were only imperfectly covered by a shallow layer of ashes or refuse.

When it is considered that of the 4,744 cisterns and wells which furnish the larger share of the water consumed, 3,408 are within contaminating distance of the known locations of these vaults, and that a large proportion of such cisterns and wells are known to be defective, enough will have been said on these points to indicate some of the causes of the high death-rate of Memphis.

MORTALITY IN MEMPHIS.

An analysis of the mortality records of the health office for the past five years furnishes the following table, which is of interest in this connection:

Causes of death.	Years.					Totals.
	1875.	1876.	1877.	1878.	1879.	
Malarial fever	127	99	121	126	68	541
Typhoid and typho-malarial fever.	23	37	41	19	18	138
Cerebro-spinal malarial fever	16	14	17	18	1	66
Yellow fever	0	0	0	2,779	497	3,276*
Erysipelas	6	1	6	1	12	26
Dysentery	66	79	63	30	25	263
Diarrhœa	30	67	61	46	36	240
Cholera infantum	52	21	31	19	32	155
Scarlatina	1	49	17	1	0	68
Diphtheria	5	8	13	11	1	38

Causes of death.	Years.					Totals.
	1875.	1876.	1877.	1878.	1879.	
Croup	13	4	5	6	11	39
Whooping-cough	25	7	1	20	1	54
Small-pox	8	0	0	0	0	8
Measles	0	13	2	35	0	50
Pneumonia	88	87	108	83	136	502
Phthisis	172	159	180	176	143	830
All other diseases of lungs	18	25	28	34	10	115
Diseases of the heart	27	27	28	29	26	137
Diseases of the urinary organs	2	6	11	1	5	25
Tetanus	10	11	13	7	5	46
Puerperal diseases	17	6	17	14	21	75
All other causes	468	308	491	552	520	2,339
Totals	1,174	1,028	1,454	4,007	1,568	9,230

From the foregoing it will be seen that, exclusive of the mortality from yellow fever, the average death-rate of Memphis is 34 per thousand, assuming the average population for the past five years to have been 35,000. On the census of 1879 the total mortality for that year was 51 in the thousand, and exclusive of yellow fever it was 30 in the thousand. The average death-rate from all causes during the three non-epidemic years was 35. Of the total number of deaths during the past five years over 15 per cent. were due to phthisis, pneumonia, and other diseases of the lungs, the excess being fairly attributable to defective subventilation of dwellings and to an undrained, retentive soil. Excremental and malarial diseases caused nearly 57 per cent. of the total, and this excess may be set down as due, in great measure, to soil and water pollution.

Under a reasonably efficient sanitary *régime*, with a good sewerage system and pure water supply, the average death-rate of the city should be reduced to about 20 in the thousand within the next lustrum. Until the social and moral status of the colored population is materially improved, it will probably be too much to expect that the theoretical standard of 17 in the thousand can be attained.[4]

It has been no part of the purpose of this summary to seek for, or to point out, causes other than such as are inherent in the conditions described, nor to fix or distribute responsibility for such conditions. Either of these lines would involve the recital of a story of civic trials and misfortunes which it would be hard, if not impossible, to parallel. To go back no further than the history of the past twelve months for an illustration: The State had already, at the close of 1878, seized one-third of the realty of the city for delinquent taxes, leaving the owners of the remaining $12,000,000 to shoulder the burden of the expenses of State, county, and city governments. To relieve itself of this impending total confiscation, the corporation, on the 31st day of January, 1879, surrendered its charter under an act of the State Legislature, which act created in lieu thereof the taxing district of Shelby County, and under which title it was attempted to administer the affairs of a community still stunned by one of the most terrible epidemics of modern history. New offices and officers, new ordinances and regulations, in short, the entire administrative and executive municipal machinery, had to be created *de noro*, and in the face of weighty doubts as to the constitutionality of a single step that was taken. Did the health authorities attempt the abatement of the most palpable nuisance, straightway the question arose as to the authority and responsibility, and there were not wanting obstructives and demagogues to interpose all manner of difficulties to the abridgment of the inalienable right of the *δι πολλοι* to be as filthy as possible. Struggling and crippled, still some progress was made during the spring and summer. Visiting sanitarians spoke and wrote in terms of warm commendation of the efforts, both public and private, they found being put forth to ward off another epidemic visitation and to redeem the city from its legacy of maladministration. With the first announced case of yellow fever, on the 9th July, all this was forgotten, and as the season wore on and the unrelieved monotony of the tale of deaths and new cases first palled upon and then irritated the public ear, Memphis became the theme for all manner of diatribes and abuse—was used to point the tritest sanitary morals and adorn the stalest hygienic tales, until it seemed as though the Bluff City had a monopoly of filth, and every other in the land was a very Dutch kitchen in point of cleanliness.

The truth is bad enough, and no attempt has been made to shirk it or to palliate it by its citizens. They are fully alive to the necessities of the situation, and though they have much to learn and more to do, they are proving both apt scholars and earnest workers. Whether enough can or will be done to avert another epidemic this season it would be premature to assert.

Some of the important recommendations of the committee on the sanitary survey have been thus far ignored or their execution postponed, whether prudently or not the future will determine. But that a marked improvement of the public health must result from what is now being done and contemplated is beyond peradventure.[5]

The following is a general summary of the house-to-house inspection at Memphis, Tenn., 1879–'80:

Total number structures and premises inspected		12,096
structures	10,873	
vacant lots	1,218	
cemeteries	5	
Total number structures inspected		10,873
dwellings, including 535 with stores or shops attached	6,386	
out-houses	3,617	
stores and office buildings	648	
churches	51	
halls, theaters, hotels, and public buildings	39	
manufactories, mills, and works	35	
academies and private schools	22	
livery stables and stock-yards	21	
cotton-presses, gins, oil-mills, &c	17	
public schools	11	
public markets and slaughter-houses	6	
hospitals and charities	5	
railroad depots and grounds	5	
fire-engine houses	4	
jail, station and poorhouse	3	
gas and water works	2	
United States Government building	1	
Total number buildings, stores, dwellings, schools, &c., excluding public buildings, &c., as well as out-houses		7,202
of wood	5,223	
brick	1,778	

[4] Without any especial relevancy to the above, but simply to record the information, the following data concerning epidemic diseases in Memphis are here appended. These have been obtained from the note-books of physicians and from other sources among the citizens, and are believed to be trustworthy so far as they go.

Yellow fever.—First epidemic in 1828; distributed pretty generally throughout the village, at that time occupying the bluff near the Mississippi, and mainly north of Market street; over 150 cases in a population of about 700; mortality, 56 recorded deaths. Second epidemic in 1855; confined principally to area south of Union street (South Memphis and Fort Pickering), but followed the bayou on both sides, north and west, to Wolf River; estimated number of cases, 1,250 in a population of about 13,000; mortality, 220 (estimated). Third epidemic in 1867; included area of epidemic of 1855, and extended north and east; estimated number of cases, 2,500 in a population of 36,000; mortality, 500 to 550. Fourth epidemic in 1873; spread pretty generally throughout the city, but more severe in northern portion ("The Pinch," "Chelsea," and eighth ward), and extended east beyond city limits; estimated number of cases, 7,000 out of a population reduced by flight to between 15,000 and 20,000; mortality, recorded between September 14 and November 9 (last death), 1,244; estimated total mortality from August 10 (first death), upward of 2,000. Fifth epidemic in 1878; no portion of city or suburbs exempt; number of cases, 17,600 out of a remaining population of 19,500; mortality, 5,150 recorded deaths. Sixth epidemic in 1879; area as general as in 1878, except in localities depopulated by flight or removal to camps; total number of recorded cases between July 9 and November 15 (cases occurred in December), 1,532 out of an estimated remaining population of 18,500, of which number 75 per cent. were "protected" in the sense of having previously had the disease; total recorded mortality, 485. The disease was brought to the city in several other years, but was not communicated to the inhabitants. This was notably the case in 1853, when upward of 80 imported cases were treated in hospital and boarding-houses without any spread.

Cholera.—First appearance in the winter of 1832–'33; number of cases and mortality unknown, but it is described as having been severe and general. Second epidemic in 1835; said to have been between 300 and 400 cases, with a mortality of about 15 per cent.; no data of population at this time, but probably about 2,400. Third epidemic in 1849; estimated number of cases about 1,200 in a population of less than 8,000; particularly severe among river boatmen and the foreign population in "The Pinch"; mortality said to have been about 33 per cent. Fourth epidemic in 1867; about 600 cases, mostly among negroes; mortality unknown; disease most severe along Causey street and vicinity (line of contact of fifth and sixth wards). Fifth epidemic in 1873; about 1,000 cases, with 276 recorded deaths; entire population is said to have been afflicted with choleraic diarrhœa.

In addition to the foregoing, *small-pox* was epidemic in 1835 and in 1873; *influenza* in 1842; *dysentery* in 1845 (local, confined to "The Pinch," about 400 cases, and between 40 and 50 deaths); *jaundice*, *erysipelas*, and *puerperal fever* in 1853; and *dengue* in 1860. Prior to 1850 diarrhœal diseases were excessively prevalent, attributed to use of well and spring water; claimed to have diminished on substitution of cistern water.

[5] During the progress of the house-to-house inspection much detailed information has been incidentally accumulated, covering to a great extent the field outlined in the schedule of questions suggested by the National Board for the "sanitary survey of a city or town." This information has been embodied in a series of special reports, which include the following subjects:

Gas and lighting.
Markets.
Slaughter-houses.
Public schools.
Hospitals and charities.
Police and prisons.
Fire establishment.
Cemeteries and burials.
Public health laws (including quarantine).

These reports are so concise as to obviate the necessity for making abstracts, but are submitted in detail as a portion of the report; as is also a *résumé* of the house-to-house inspection, in which is embraced the chief points of sanitary interest, arranged by wards for convenience of reference. This is believed to be comprehensive and accurate enough to enable the sanitary authorities to outline much, if not all, of the preliminary work which it will be possible to accomplish during the present season. It is founded upon the details of 9,508 inspections; which details have, in turn, been tabulated on 206 large folio sheets, each of which contains, in single lines, the sanitary history of 50 premises—in the aggregate a total of upward of 176,000 items. In this tabulation the street numbers are arranged continuously, and by this means every structure and lot within the city limits is believed to be accounted for.

Total number of buildings, &c.—Continued.		
of wood and brick	187	
stone	13	
iron	1	
under 5 years old	793	
between 5 and 10 years old	1,731	
over 10 years old	4,678	
sub-ventilation good	2,204	
bad	2,030	
none	1,453	
with cellars	891	
basements	624	
Total number cellars and basements		1,515
6 feet deep or less	342	
7 to 8 feet deep	768	
9 feet deep and over (deepest 20 feet)	405	
ventilation good	1,235	
bad	280	
dry	1,009	
damp or wet	506	
clean	1,089	
foul	426	
Total number dwellings		6,386
of one story	4,188	
one and one-half stories	145	
two stories	1,741	
three stories	253	
four or more stories	59	
Total number dwellings of one story		4,188
with one room	194	
two rooms	1,015	
three or more rooms	2,979	
Total number yards and areas of stores and dwellings		7,211
drainage good	5,992	
bad	1,116	
fair	103	
surface condition clean	5,802	
foul	1,409	
Total number privies		5,914
under house	451	
adjoining house	165	
within 10 feet of house	367	
between 10 and 50 feet from house	3,226	
over 50 feet from house	1,705	
clean	2,246	
foul	3,607	
overflowing	61	
Total number water-closets		398
clean	273	
foul	125	
Total number urinals		153
trapped	78	
untrapped	75	
Total number earth-closets		6
Total number sinks		374
trapped	78	
untrapped	296	
Total number sewer connections		157
sound	147	
unsound	10	
Total number cess-pools		84
clean	5	
foul	79	
Total number cisterns and wells		4,744
within 10 feet of privy	369	
between 10 and 50 feet of privy	3,039	
over 50 feet from privy	1,336	
Total number hydrants		874
Total number public nuisances		1,184
Total number pools of stagnant water		124

Total number cases of infected material		569
in use	499	
stored	65	
held as merchandise	5	
Total number animals		2,616
Total number geese and other fowls		8,020
Total population		30,659
white	16,705	
colored	13,954	
Total number families		7,384
white	3,775	
colored	3,609	
Total number dwellings occupied		5,584
by one family		
by two families		
by three or more families		(*)

B.

REPORT OF DR. CHARLES SMART.

WASHINGTON, D. C.,
December 30, 1879.

SIR: I have the honor to submit the following report of the practical results of my analysis of the water supplies of certain towns and villages in Mississippi and Tennessee.

My instructions did not require an exhaustive chemical analysis of the various waters with the quantitative determination of the saline matters which might be present in them. There was contemplated only what has been called a *sanitary analysis*, an investigation into the question of wholesomeness or unwholesomeness. But as a water which is unfit for potable uses from excess of metallic, earthy, or alkaline salts can usually be detected by its taste or hardness, a sanitary examination becomes practically an investigation into the organic matter which is contained in the sample.

The presence of organic substances can easily be detected in most waters, for there are few which are organically pure; but there is no royal road to an estimation of the quantity, nor to—what is of as much importance—an appreciation of the quality. The examination must consist in instituting a series of experiments on the organic matter, on the substances which accompany it in the water, and on those derived from it. These various witnesses are, as it were, interrogated, and from a consideration of their testimony an opinion is formed as to the quantity of the organic contamination, as to its origin in the animal or vegetable kingdom, as to its source, whether near or remote—in a word, as to the wholesomeness or unwholesomeness of the water which contains it.

The examination being of necessity complex, and each point susceptible of determination by different processes, all of which have their advocates, a consultation was held with Prof. Ira Remsen and Dr. Harmon K. Morse, of the Johns Hopkins University, concerning the ground to be covered by the examination in each instance and the best mode of accomplishing it, consistent with portability of apparatus and other considerations. I am especially indebted to these gentlemen for calling my attention to Tiemann's modification of Schulze's process for the estimation of nitrates, which they have used for some time in their water examinations, and the accuracy of which they have practically determined.

The experimental points decided upon as essential were—

First. The total solids as obtained by the balance after the evaporation of a given quantity of water;

Second. The separation of this total by ignition and the balance into substances dissipated by heat, such as organic matter, nitrates, &c., and the inorganic residue;

Third. An estimation of the amount of oxygen required to oxidize the oxidizable substances present in the water, as affording a view of the organic matter from one side; while a view of the same impurity was to be obtained on another aspect by—

Fourth. The break-up of the organic substances and estimation of their nitrogen in the form of albuminoid ammonia;

Fifth. The quantity of free ammonia present;

Sixth. That of nitrous acid;

Seventh. Of nitric acid;

Eighth. Of chlorine; and,

Lastly. The microscopic appearances of the sediment.

With these data and a knowledge of what might be termed the natural history of the water, whether rain, well, spring, river water, &c., and of its surroundings, it was conceived that an accurate opinion could be given as to its quality, not by the operator only, but by any one conversant with the processes of water analysis, no matter what the method he adopted in the formation of his opinion.

*Statistics of morbility and mortality, as gathered by the house-to-house inspection, were so largely matters of memory and not of record that they are not thought worth presenting in this connection.

In accordance with instructions, I proceeded to the town of Jackson, Miss., which I found mainly supplied by rain-water collected and stored in underground cisterns. As the time at my disposal did not admit of the examination of a sufficient number of these waters to enable an opinion to be given in general terms upon the character of the supply, I approximated to a generalization by selecting—

First. Water supplying public institutions, such as the State penitentiary, the deaf and dumb asylum, the institute for the blind, &c.

Second. Public or semi-public cisterns.

Third. A few samples from the cisterns of well-to-do citizens.

Fourth. A few from those of the colored people.

Fifth. Samples from houses in which there was or had recently been malarial remittent fevers.

Thirteen samples were furnished and analyzed, with the following results:

	Cisterns.	Water good.	Water fair.	Water bad.	Sewage.
Sound	2	....	1	1	....
Siping	3	1	1	1	....
Leaky	8	4	1	3	....
Total	13	5	3	5	....

This is manifestly a bad showing—only two sound cisterns out of thirteen, one containing a water rank with vegetable impurity, while the contents of the other are not above suspicion. That the cisterns are not contaminated with sewage matter is owing to purity of soil, and not to their own merits. Several of them are neither more nor less than shallow wells, receiving more of their contents by percolation than by inflow from above.

One well-water, from northwest Jackson, was received for examination. It was organically impure, even had its use not been contra-indicated by the amount of its earthy constituents.

Having been informed by Dr. Wirt Johnston, secretary of the State board of health, that during the 1878 epidemic of yellow fever the disease passed from Jackson eastward along the line of railroad and ravaged all the settlements along the track to Meridian, except the village of Brandon, I proceeded to that place and secured samples from the sources of supply most generally used. These consisted of three wells—two springs and one cistern. The last was sound, but contained bad water. The springs were good, but one (Youst's) would have been better had the arrangements for preserving it from surface admixture been other than of the most primitive character. Of the wells one furnished good, another fair or usable, and the third an impure water.

The next place at which my instructions called for an investigation was Grenada, Miss. Here the supply was found to be from wells averaging about twenty-five feet in depth. They were all free from any excess of earthy salts.

Eighteen samples were examined, of which fourteen were good waters, one fair and three bad. Of the last, one (Doak's) would probably have shown as a good water had a fair specimen been furnished for analysis. On investigating the well, after examination of the water, it was found that a new pump had been inserted on the day before the sample was collected and that the well was unusually turbid from this interference. The two remaining on the record as bad waters were undoubtedly contaminated with sewage.

The comparative freedom of the wells in this town from sewage infiltration is owing to the absence of privy vaults. The Mississippi State board requires the use of dry earth and surface receptacles, and Grenada has been very thorough in her adoption of this surface system.

For samples of the supply of small country settlements I proceeded from Grenada to Duckhill, Miss., where I examined three wells, the waters of which were good, although possessed at times of a sulphur taste on account of a blue-clay stratum which lies below the water-mark.

Returning from this place to Grenada, I collected at Elliott, Miss., samples from three wells, two of which were good and one bad.

At Payne's place, which is finely situated from a sanitary point of view, but which furnished twenty-five cases and thirteen deaths out of one hundred people living there during the 1878 epidemic, I obtained samples from two cisterns and one well. The latter furnished excellent water, but both cisterns, although sound, contained very impure supplies.

At Green's Chapel, the only well yielded a very satisfactory water.

If the above samples from country places can be admitted as illustrations of the well-water supply of such settlements generally, their freedom from organic impurity, from surface washings and sewage, is a matter for congratulation.

Grenada and its vicinity is thus seen to have an excellent water supply, the impurity in the few bad cases being due to local and preventable causes.

At Holly Springs, Miss., where examinations were next required to be instituted, twenty-five waters were analyzed, of which eighteen were from wells, five from underground cisterns, and two from springs.

The following tabulates the results:

	Cisterns, &c.	Water good.	Water fair.	Water bad.	Sewage.
Sound	3	3	....	....	....
Siping	1	1	....	....	....
Leaky	1	....	....	1	....
Wells	18	9	2	3	4
Springs	2	1	....	1	....
Total	25	14	2	5	4

Of the wells contaminated by sewage in this town some are owing to pollution of soil by privy vaults now disused; one arises from the neighborhood of a vault which is yet in use, another from the immediate proximity of a cow-stable, combined with a break in the curb which admits of surface inflow in wet weather. Some of the bad waters can have the organic matter contained in them accounted for only by the presence of large trees, the roots of which may lead surface water into the well with insufficient filtration, or, being in a state of decay, may charge the inflowing water with their detritus. In several of these cases the surface around the well and adjacent tree-trunks is garden ground freely manured with farm-yard refuse.

In passing from Mississippi, where privy vaults have been abolished in favor of the surface system, to Tennessee, where they continue in general use, the character of the well-water supply was found to undergo a marked change. Sewage pollution, which up to this time had been met with only in exceptional cases, was in Brownsville, Tenn., discovered to be the general condition.

Eleve nwells were examined, of which only two were good. Two furnished fair or usable water, one was bad from vegetable impurity, and six were found largely contaminated by sewage from vaults. Incidentally, it was noted by Dr. W. W. Taylor, secretary of the local board, that three cases of typhoid had occurred in a house (that of Judge Bond) supplied by one of these polluted wells.

Only two cisterns were examined, one of which was sound and contained a good water, while the other was leaky—a veritable shallow well—and contained a most impure supply.

In a thriving town like Brownsville, where the soil has become so contaminated as to infect the wells in this manner, it is high time for the establishment of a sewerage system. The vaults should be abolished in the mean time and the Mississippi surface system instituted. But this is beyond the limits of my inquiry, and is mentioned only in passing.

So far as the water supply is concerned, it is imperative that some action be taken by the local board. The town is ripe for decimation by typhoid fever and other diseases which originate in impurity of soil and are propagated by impure water. The proper remedy is the organization of a water company and the introduction of a supply from a suitable source entirely beyond the risk of pollution by the consumers. But if this requires an expenditure exceeding the means of the town, recourse must be had in the mean time to a rain-water supply, or, in certain localities outside of the denser areas, to deep wells lined with brick to exclude infiltration from the surface.

The city of Memphis, Tenn., was found to depend for its supply upon three unequal sources, which, in the order of their importance, were—

First. The underground cisterns, of which it was estimated that there were no less than four thousand in use within the city limits.

Second. The wells, of which there were quite a number, but many of them were not used on account of a bad repute, based principally on the hardness of the water or the taste of its inorganic salts.

Third. The hydrant water, or that furnished from the Wolf River by the Memphis Water Company.

Eighty samples of cistern water, from various parts of the city, were examined, with the following result:

	Cisterns.	Water good.	Water fair.	Water bad.	Sewage.
Sound	36	25	8	3	....
Siping	12	2	1	2	7
Leaky	32	6	2	....	23
Total	80	33	11	5	31

But these cannot be viewed as illustrating the condition of the four thousand cisterns in the city, inasmuch as, although they came from all quarters, they were in every instance selected samples. Many were brought for examination by citizens whose very anxiety concerning their water supply might be looked upon as an argument in favor of the probability of the cistern being sound and the water pure. Other samples, as those from the public schools, were sent in mainly for the purpose of verifying their purity. On the other hand, samples brought by the medical inspectors for analysis were presented on account of their probable impurity, while the last nine of the waters which were examined were selected by the analyst from a list of those known by preliminary examination to be impure.

But while one may not generalize concerning the Memphis cisterns from this table, it shows conclusively that the impurity of the soil is such that when a leak exists in the cistern, the probabilities are strongly in favor of a pollution by sewage of the contained water.

As the complete sanitary analysis of a water occupied so much time, and as the number of cisterns was relatively so immense, a ready method was sought by which the condition of a cistern and the probable quality of its contents might be determined.

At first sight, the amount of total solids in a stored rain-water would seem to afford the means of judging as to the soundness of its cistern, any sipage or leakage of necessity carrying into the water earthy and other salts which would increase the total. But several instances occurred in the above analyses where lime carbonate in the residue came manifestly from the cement lining of a sound cistern. This method had therefore to be excluded as fallacious.

No objection, however, attached to an estimation of the chlorine present in the water as an index of the condition of the cistern. Rain-water contains a small proportion of chlorine, the amount varying with the condition of the atmosphere and the purity of the shedding surface. In the inland city of Memphis the amount naturally existing in its rainfall is not large. Rain which was shed from the roof of the Peabody Hotel, during a heavy fall on December 3, contained .075 parts of chlorine in the 100. A cistern water which does not contain more than this must be undeniably free from soil pollution, for the finished analysis showed the soil to be so charged with chlorides that the slightest siping or leakage was marked by an increased chlorine figure. A small excess over the normal might exist and the cistern be sound, the increase being due to an unusual foulness of the roof. As much as .15 parts of chlorine was shown to be consistent with soundness, but as the amount increased beyond this figure the probability of leakage became proportionally great. A series of chlorine determinations was then made on cistern samples collected from all the wards of the city; and, as no selection was exercised, the results may be viewed as expressing the condition of the Memphis cistern supply.

In tabulating them, those waters which contained less than .075 parts of chlorine are set down as from *undoubtedly sound* cisterns, the supply itself being in all probability of good quality. In cases where the amount lay between .075 and .15 parts the cisterns are recorded as *probably sound*, the increase being due to vegetable contamination and foulness of the shedding surfaces, although in a small proportion of the cases it might be owing to a slight siping from the soil. Here the water must be considered of doubtful quality. In those instances where the chlorine figure lay between .15 and .30 parts, the cistern is reported as probably *siping*, the increase coming from the soil, and being in all likelihood a sewage accompaniment, although in rare cases it might arise from a large organic impurity without leakage on the part of the cistern. In either case the water is probably bad. Lastly, where the amount exceeded .30 parts in the 100 of water, the cistern is viewed as undoubtedly *leaky*, and as containing an impure water supply.

CISTERNS EXAMINED.

Undoubtedly sound	127
Probably sound	82
Probably siping	82
Undoubtedly leaky	158
Total	449

In estimating the condition of the Memphis water supply from this source, there should be added to the above figures nine leaky cisterns, making 167 in a total of 458. These nine samples were brought in for the chlorine experiment along with the others, but a complete sanitary analysis having been subsequently made to determine the characters of their impurity, they were removed from the list of cisterns examined to that of cistern-waters analyzed.

The large proportion of leaky cisterns, with the strong probability of sewage contamination in each instance, requires that some action be taken to insure a better water supply for the city. But whatever may ultimately be done in this direction, the citizens will have to depend upon their cisterns for some time to come. Yet the character of many of these waters is such as to call, in the interest of the public health, for an immediate interference. In several instances I was enabled, by personal communication with the owners, to warn and advise. But in other cases, where the water was brought by the inspecting officers, I did not have the means of notifying the consumers. To overcome this difficulty and enable action to be taken in the cases of certain cisterns, which from their excessive leakage appeared to require immediate attention, I sent a communication embracing some of the facts here recorded to Dr. R. W. Mitchell, member of the National Board of Health, and of the committee on the sanitary survey of Memphis, with a list of sixty-five of the worst cisterns and a map giving the location and character of the whole number examined.

But the facts developed by the analyses constitute only a small part of the total array which demands investigation in the sanitary interests of the city. Among the thirty-five hundred unexamined cisterns there are at least twelve hundred which leak. These should be singled out by the local authorities by means of the chlorine test, and their abandonment should be ordered if there is manifest danger from soil pollution in their surroundings; but if there is no such danger it would be sufficient to direct them to be cleaned out and relined with a thick coating of Portland cement.

The analyses of the well-waters demonstrated the impurity of the city's soil in as marked a manner as did those of the leaking cisterns. Of nineteen wells, all of which were reported as brick-lined to exclude infiltration, fourteen contained sewage matter, either in the recent state or oxidized by its passage through the soil. Of the five remaining, the use of one was contraindicated by an excess of earthy salts, so that there were in reality only four waters, out of this list of nineteen, which could be warranted as fit for use. Of those which showed the presence of organic matter in an oxidized condition, one—Pontotoc—was so free from recent contamination, and at the same time contained such a small proportion of oxidized matter, that the *water* might be considered as wholesome. The *well*, however, must be looked upon as dangerous, inasmuch as an increased flow of water into it might at any time bring unaltered sewage to pollute the supply.

The waters might be thus classified:

Four good in every respect.

One doubtful, as liable at any time to contamination.

Eight bad in every respect.

Four potable so far as recent organic matter is concerned, but condemned on account of oxidized organic matters and excess of inorganic salts.

One unwholesome solely on account of dissolved inorganic salts.

One potable so far as inorganic constituents are concerned, but condemned on account of organic pollution.

In connection with the cistern and well water supply of Memphis I have especially to thank Dr. R. W. Mitchell, member of the National Board of Health, and Dr. Frank W. Reilly, superintendent of the house-to-house inspection, for the assistance they furnished in securing the necessary samples for analysis, and for many valuable suggestions connected with my work.

Besides the cisterns and wells above enumerated, the examinations at Memphis included one water from a tank or reservoir built above ground, one rain-water collected direct from a roof, in order to place on the record the sanitary analysis of the rainfall which was then filling the cisterns, and thirteen samples of river water, one from Elmwood Creek, three from the Mississippi, and nine from the Wolf River.

The supply furnished by the Memphis Water Company is drawn from Wolf River, a short distance above its mouth. It is pumped from the river and distributed without any intermediate process of purification.

During the period of my stay in Memphis Wolf River was an uninviting stream, turbid with particles of red clay, which, on account of their extreme minuteness, rendered filtration difficult—from the tendency of the particles to clog the filter—and sedimentation practically impossible. Entangled with the clay there was much vegetable matter, which could be separated only by the separation of the mineral particles. Hence analyses of the water made on samples taken on November 12 and 18 and December 2 and 15 showed it to be unwholesome in a high degree. Many householders who were doubtful as to the condition of their cisterns made use of this water after passing it through a charcoal filter. One such filtered sample was examined and found to be a specimen of very pure water. Those citizens only who made use of the filtered water had an interest in this result, which is to be set to the credit of the charcoal, not to that of the water. Sedimentation was accomplished on the small scale in a few instances by filling cisterns with the river water at a time when the stream was low and comparatively clear. Three samples of water stored in this manner were examined and found to be of good quality. But the long-continued sedimentation in a clean cistern which is to be credited with this result is a process which, like the charcoal filtration, can be accomplished only in individual cases.

It is no doubt true that at other seasons of the year this stream is less impure than at present, but a water, to be suitable for the supply of a large city, should be pure at all seasons, or, if not, it should at least be susceptible of purification on the large scale. The Wolf River water, unfortunately, cannot be thus purified. Any filter which might be constructed would be clogged within a few hours, and a series of reservoirs, to permit of subsidence, would require to be of extravagant size unless some means were devised to hasten the process.

With the view of ascertaining the character of the water higher up the stream than the location of the water-works, a sample was procured on November 18 from Raleigh, a point nine miles distant from the city. This specimen was found to be somewhat less impure than that collected on the same day near the water company's inflow. But it was unwholesome, from an excess of vegetable matter, and as objectionable as the other when viewed as a possible source of supply. It was loaded with the same red clay which renders the hydrant-water so difficult of purification.

In order to effect a comparison between the waters of the Mississippi and Wolf Rivers, Capt. W. H. H. Benyaurd, Corps of Engineers, United States Army, who furnished the samples already mentioned, collected specimens of the Mississippi on November 18 and

December 2 and 15. But these were insufficient for the purpose. The periods of flood in the two streams are not coincident. On the first of the above dates Wolf River was somewhat swollen, while the rise in the Mississippi had not commenced. The Mississippi water was then a fair sample of river water, containing a certain amount of vegetable impurity, but by no means so much as has been recorded as existing in some Western streams of good repute as to wholesomeness. On the second date, the Mississippi sample, although very turbid—the river being 7½ feet above low-water mark, and rising—was comparatively free from organic matter. On the third occasion, the river had risen to 10 feet, and was exceedingly turbid. When the Mississippi is at this height, its waters impede the outflow from Wolf River, causing stagnation and flooding in the mouth of the latter. The sample presented the same amount of organic impurity as that furnished by the Wolf River water collected on the same day, enough to condemn it as unfit for potable use.

To establish a comparison between the streams, the annual lines of organic impurity should be determined. But continued observations of this nature do not appear to be called for to decide the question as to which is the better water for a town supply. Both are pure when at low-water mark, and free from impurity. Both are impure when swollen and turbid. So far they agree. But the red clay of the smaller stream rises into turbidity more readily and falls more slowly than the more siliceous sedimentary matters of the Mississippi. This would suggest that the annual period of turbidity and consequent impurity is less in the Mississippi. But the possibility of purifying a supply drawn from it should cause it to be preferred, even if its period of turbidity were greater than that of Wolf River. So far as dissolved inorganic substances are concerned, both waters are of good quality.

This report has, of course, no consideration for the engineering and financial sides of the question.

I have the honor to accompany this report with an itemized list of the various well, spring, river, and cistern waters analyzed, and of the Memphis cisterns tested chemically for leakage. I also append a copy of the letter referred to above as having been sent to Dr. R. W. Mitchell with the view of reaching the local authorities of Memphis.

I have the honor to be, very respectfully, your obedient servant,

CHARLES SMART,
Captain and Assistant Surgeon, U. S. A.

THOMAS J. TURNER, M. D., U. S. N.,
Secretary National Board of Health, Washington, D. C.

MEMPHIS, TENN., *December* 19, 1879.

SIR: I have the honor to report to you that I have concluded my investigation as to the character of the water supply of Memphis; that I have analyzed a sufficient number of the waters collected and stored in the different wards of the city of Memphis to be able to generalize on summing up my results.

Whatever system of water supply may be adopted by the city in the future, the point of immediate interest is the condition of the cisterns. These will have to be used in the mean time, while awaiting further developments. During my examinations I have met with many waters so polluted by sewage infiltration that an immediate interdict on their use appears called for. In many instances I have been enabled to do this by personal communication with the owners; but in other cases, where the water has been brought to me by the inspecting force, I have not had means of notifying the consumers.

In view of the importance of this subject, and of the large amount of facts gathered by analysis during the past few weeks, I have conceived it proper, without trenching on the ground to be covered in my report to the secretary of the National Board of Health, and without awaiting the routine transmission of official communications, to furnish you with some memoranda from my laboratory record, that, subject to your approval, they may be laid before the local authorities and utilized. To the better understanding of the subject a few words are necessary.

On commencing my investigation in this city I made an exhaustive analysis of every water which was presented, determining the total amount of solid matter dissolved in the water, the organic matter and all those substances which accompany, or are formed by, the breaking up of the organic matter. When a large number of these were collected it became manifest, on reviewing them, that the amount of chlorine present in a cistern water could be made the test of soundness or leakage of the cistern. On superficial consideration it would seem as if the total amount of dissolved solids would be the best criterion, as rain-water, properly stored, contains such a small proportion of these matters; but many instances occurred showing the presence of lime in comparatively large quantities without that corresponding increase in the chlorine which would be expected if the lime salts siped in from the soil. The inference was that the lining of the cistern was undergoing solution by the water—an important fact as bearing on the permanence of a cistern in its sound condition, but rendering the total solids, as determined by the balance, of no value as a test of leakage. On the other hand, rain-water contains but the merest trace of chlorine, collected, in its fall, from the sodium chloride which exists in the dust of the atmosphere. It gathers a little more from the roof which sheds it; so that rain-water taken from a cistern gives perceptibly more chlorine to the chemist than that collected in clean dishes. From a sound cistern the water can gather none, so that its presence in excess of the amount normal to roof-caught water is indicative of siping or leakage from the soil. In this city no water which has percolated the soil can be found without chlorine, and hence no leak can exist in a cistern without its presence being detected by a determination of the chlorine present in the contained waters. Having arrived at these conclusions, an examination was made of a large number of cisterns by means of the chlorine determination. Many were found so strongly charged by this contribution from the soil that a larger quantity of water was obtained from the cisterns in question, for fuller investigation, to determine the quality of the matter, indicating such an amount of chlorine leakage. The full analysis which I have placed on record gives a value to the simple chlorine determinations, by indicating the probable quality of the water, which corresponds with a given chlorine impurity. But this is a matter for my detailed report.

Accompanying this communication is a map of the city, on which are indicated the sites of 80 cisterns, the water of which has been examined exhaustively, and of 450 cisterns the condition of which has been determined by an estimation of the chlorine. On the map a black circle marks the position of a sound cistern with a presumably good water; a blue circle marks a probably sound cistern; a green circle a cistern which probably sipes a little, or which, in a small proportion of the cases, obtains its excess of chlorine from the accumulations of vegetable matter washed down from the roof; a red circle marks the situation of a leaky cistern, which, if the privy vault adjoins, contains contamination from that source. The circles which are filled in with solid color—black, green, red—indicate sound, siping, and leaky cisterns respectively, and the waters of which have been exhaustively examined. The letters G, F, B, and S express the quality of the examined waters, as good, fair, bad, sewage, as the case may be.

Many of the 530 cisterns leak, but some, of course, to a much smaller extent than others. I accompany this with a list of the more exaggerated cases in which it appears to me that immediate action is demanded. The others, not in this list but marked as "leaky" on the map, require attention, but not so imperatively. These should be filled up, if there is manifest danger of soil pollution from these surroundings; but if there appears no such danger, it would be sufficient to clean them out and reline with Portland cement.

Another point which deserves attention is this: The proportion of leaky cisterns is large—in round numbers one-third of the whole—while again of these the number largely contaminated may be judged of by the list. The number examined (530) is sufficient to indicate the probabilities in the 4,000 (?) or more cisterns which Memphis owns. If it appears imperative, in the sanitary interests of the community, to take action in the cases which have been examined and pronounced polluted, it is no less imperative to find out and remedy the many cases which have not been examined, but which of necessity exist. To this end I would respectfully suggest a continuance of these chlorine determinations by some competent person in order that the leak may be stopped in those cisterns which it is proper to reline, and that the dangerous ones be destroyed. These experiments are simple, do not occupy much time, require no expensive apparatus, and are accurate in their testimony as to the condition of the cisterns.

I have the honor to be, very respectfully, your obedient servant,

CHARLES SMART,
Captain and Assistant Surgeon, U. S. A.

Dr. R. W. MITCHELL,
Member of the National Board of Health,
and of the Committee on Sanitary Survey of Memphis.

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PATHOLOGICAL HISTOLOGY OF YELLOW FEVER.

[By J. J. WOODWARD, Surgeon U. S. Army.]

The following remarks on the pathological histology of yellow fever were prepared at the request of the National Board of Health, and submitted by Dr. Woodward April 6, 1880:

ARMY MEDICAL MUSEUM,
April 6, 1880.

Dr. JAMES L. CABELL,
President of the National Board of Health:

DEAR SIR: November 4, 1879, I had the honor to receive a letter from the secretary, requesting me, in the name of the National Board of Health, to examine a number of pathological specimens from subjects dead of yellow fever, collected by the commission sent to Havana during the previous summer. I was asked, in case the specimens proved to be of such character and in such a state of preservation as to permit it, to "prepare a report on the pathology of yellow fever," to be published with the reports of the Havana Commission, or, as an alternative, at least to "indicate the direction in which research is most needed and is most likely to prove of value." At a subsequent period I received from the secretary of the Board a number of permanently-mounted microscopic slides prepared by Dr. J. Guiteras, one of the members of the commission, from specimens collected at the same time as those sent me.

I replied to the letter of November 4 that I was ready to comply with the wishes of the Board to the extent of my power; and accordingly, since that time, I have not only made a microscopical investigation of the pathological pieces sent me, so far as their condition permitted, and examined with care the mounted preparations of Dr. Guiteras, but have studied the most important recent contributions to the pathological anatomy of this disease, in order to acquaint myself as fully as possible with the present state of knowledge on the questions at issue.

I regret to say that the pathological pieces sent me were not in a condition for very satisfactory study, the autopsies having been performed too long after death (5 to 18 hours). We have the testimony of a number of trustworthy observers that cadaveric changes occur much more rapidly after death from yellow fever than after death from ordinary non-malignant acute diseases, so that the period mentioned, which in the tropical climate of Havana during July and August would be, I should suppose, quite sufficient to impair the value for refined histological researches of the normal tissues of those dead by violence, might be expected to give rise to still more serious changes in those dead of yellow fever. To this cause also in part I attribute the circumstance that I found so many of the permanently mounted sections gave very unsatisfactory views of the structures preserved.

Nevertheless, I placed the pathological pieces received in the hands of my assistant, Dr. J. C. McConnell, who has prepared such sections as the condition of the material permitted; and these I have carefully studied and compared with those mounted by Dr. Guiteras. What I have thus been able to observe will be related in subsequent portions of this report.

The possibility that the material placed at my disposal for study might not prove adequate for the investigations required had evidently been considered by the Board before the letter of November 4 was written, for it contains the offer of additional material if desired. While I appreciate the motives which prompted this offer, and should be unwilling to spare labor or pains on any investigation that I believed would afford a reasonable chance of throwing light directly or indirectly on the nature of this fatal disease, I do not see my way clear to accept it, and for the following reasons: My recent studies with regard to the present state of our knowledge of the pathological histology of yellow fever have satisfied me abundantly that further researches in connection with this disease to be fruitful must be conducted on the spot. The structural conditions observed in sections made from the freshest possible material hardened *secundum artem* by alcohol and other preservative fluids, must be compared with those seen by the same observer in frozen sections and other extemporaneous preparations of perfectly fresh material, unmodified by hardening reagents. Moreover, since the condition of the diseased organs changes with the progress and intensity of the disease, and the appearances to the naked eye as well as the degree and even the character of the histological alterations vary, the microscopist who is to investigate these minute changes should either make the autopsies himself or at least be present at them, to note the macroscopic appearances of the diseased parts, to select for his own use the pieces most suitable to be submitted to the action of hardening reagents, to place them with his own hands in the appropriate fluids, as well as to make those extemporaneous microscopical examinations which are necessary for the interpretation of his subsequent work, and which can only be made in a satisfactory manner by the side of the dead body, as the parts to be examined are removed. The force of these remarks will, I think, be appreciated when I come to discuss *seriatim* the discrepant accounts of the chief lesions in this disease.

Frankly, therefore, I have no hopes that any important additions to our present knowledge will be made by the study, no matter how laborious or skillful, of fragments of organs removed from the bodies of those dead of yellow fever, and sent to some far-distant histologist for such incomplete investigation as alone can be possible under such circumstances. It would be easy to waste a great deal of precious time and labor in this direction with very little fruit. In my opinion we shall have to wait for material progress in this important field until it shall be possible for some protected individual, thoroughly trained in the best modern histological methods, and well acquainted with the naked-eye appearances of healthy and diseased organs after death, as well as with the normal and pathological histology of the organs chiefly concerned in this disease, to devote himself exclusively, and probably for a considerable time, to the necessary investigations at some place in which the disease habitually prevails. Whoever undertakes this task must be accustomed to the climate, or he will be unable to work to advantage, and he must have had the fever, or he will be far more likely to add another to its victims than to contribute anything to our knowledge of its nature. I do not suppose that such an individual as is here indicated can be found at the present time. Some suitable person will have to be selected and specially trained for this delicate and difficult work. This is a field in which liberal assistance could advantageously be afforded by the general government, for the field of labor is one which in this country offers little or no pecuniary reward, and yet will demand the whole time of the investigator for a considerable period.

I am not one of those, if there be any such, who believe that the whole pathology of this disease is embraced in its macroscopic and microscopic pathological anatomy, and that if we only push our histological researches far enough we will arrive by this road at a complete understanding of its nature. The anatomical investigation is but one of those lines of research which must be conducted to a successful issue if we are ever to arrive at a right understanding of this disease. It is, however, an indispensable one. The various views of the nature of yellow fever which have hitherto prevailed have always been intimately connected with such anatomical knowledge as those who have propounded them possessed, and more correct views are not likely to be attained in the future until our knowledge of the pathological anatomy of the disease is far more complete on the histological side than it is at present. In view of the considerations presented, I have arrived at the conclusion that the utmost I can conscientiously undertake to do, in compliance with the wishes of the Board, is to accept the last alternative presented by the letter of November 4, and endeavor to indicate the direction in which future researches with regard to the pathological histology of this disease appear to me to be most needed and most likely to prove of value.

I undertake this work with great modesty, since the disease is one I have never seen, but I have endeavored to make myself acquainted with the best recent observations, and bring to their consideration such general knowledge of pathological histology as I have acquired by studies which now extend over more than a quarter of a century. I hope therefore that the suggestions I am about to present may not be without value to those who may hereafter undertake to investigate the histological lesions of yellow fever.

These suggestions can be most advantageously presented in connection with a brief statement of the principal differences between the accounts of recent observers; for evidently our first step forward must be to endeavor to ascertain by observation which of these discrepant statements is in accordance with facts, or, if in any case none of them fully represent the facts, to ascertain what these actually are. I shall make no attempt at a complete analysis of the very voluminous recent literature, but only refer to what appear to be the most significant original observations.

The histologist who may undertake to study the lesions of yellow

fever, will find it necessary to the interpretation of the conditions observed in the dead body to make certain investigations during the progress of the disease at the bedside of the sick.

A.—MICROSCOPICAL INVESTIGATIONS AT THE BEDSIDE OF THE SICK.

These refer especially to the blood, the black vomit, and the urine.

1. *The blood.*—And, first, as to the examination of the blood, which has been regarded by so many physicians as the primary seat of the specific changes produced by the yellow-fever poison, or at least as the vehicle by which the poison is conveyed to the nervous centers or other parts supposed to be the first seat of morbid action. The most important discrepancies between the modern accounts of the pathological histology of the blood in yellow fever refer to the condition of the red and white corpuscles, and to the alleged detection of low vegetable forms, supposed to be related to the causation of the disease.

Can any change be detected with the microscope in the red corpuscles of yellow-fever blood? The old observation of Bienperthuy (1844), who affirmed that even at an early period of the disease "the parenchyma which serves as an envelop to the globules was destroyed," was long ago contradicted by that careful microscopist Professor Joseph Leidy (1854),* who was unable to discover "the slightest indication of such a process," and reported that in the cases he examined with the microscope "the corpuscles were found apparently unchanged." Yet the opinion that in this disease the red-blood corpuscles in some way break up, and that perhaps the characteristic icterus is due to the "transformation of their hæmatine into bile pigment within the circulation," has continued to find adherents, as may be seen by the article of Haenisch, in Ziemssen's Cyclopædia. Two of our own countrymen, Dr. Joseph Jones and Dr. H. D. Schmidt, have recorded observations, made in New Orleans during the epidemic of 1878, which appear to lend some support to this opinion. Dr. Joseph Jones observed that in the blood drawn by cut cups from yellow fever patients, "the colored corpuscles presented a crenated appearance," due to "irregular elevations or exudations of the surface of the corpuscles," or "presented a stellate and granular appearance, as if minute globules were forming upon the surface of the cell membrane."†

Dr. H. D. Schmidt carried his microscope with him into the hospital ward, and took, it would appear, many precautions in order to observe the blood as fresh as possible. He examined the blood of fifteen cases, and in all, "with the exception of two, the colored blood corpuscles presented the crenated form." Dr. Schmidt regards this change as probably "retrogressive in character, indicating a loss of vitality on the part of the blood corpuscles," and, quite in harmony with this view, he recognizes the presence of "hæmoglobulin escaped from the blood" in the glandular cells of "the liver and some other organs," and mentions that he observed "free hæmoglobulin" in one of the specimens of blood he examined, although he remarks that this "is a phenomenon sometimes even met with in the examination of normal human blood."

Dr. John Davy (1847) long since observed that when blood taken from the body of a subject dead of yellow fever was examined under the microscope "the corpuscles were seen to be corrugated, as if from incipient putrefaction;" but he did not recognize this condition in blood taken from living patients, nor has it attracted the attention, so far as I know, of any recent observers other than those cited above. Deputy Inspector-General Robert Lawson, writing in 1862 of the yellow fever of Jamaica, remarks: "It seems still a common belief that the blood in yellow fever is in a dissolved state. * * * The blood, however, is not dissolved, but the globules remain distinct and well formed." In like manner, Dr. J. Crevaux, a French naval surgeon, who has studied with evident care the pathological histology of yellow fever during the epidemic of 1877 in French Guiana, declares that he found no sensible alteration of the blood globules. Less definitely, Dr. M. A. Guichet, a French military surgeon, writes, from examinations made during the Madrid epidemic of 1878, that he found the red-blood globules little altered or healthy; but these examinations appear to have been made after death.

During the summer of 1879, Surgeon George M. Sternberg, one of the members of the Havana commission referred to at the commencement of this paper, spread out thin and dried, on glass slides, in order to photograph them, ninety-eight specimens of blood taken from fifty-one cases of yellow fever (mostly soldiers in the military hospital of San Ambrosio), without, in his opinion, observing any greater tendency to crenation than is observed in normal blood—an opinion which, I may say, is sustained by the beautiful photographs taken by this gentleman.

I cannot, however, feel, after perusing the publications in which the foregoing discrepant statements are set forth, that any one of them is based upon such exhaustive and thorough researches as to warrant us in regarding it as final. On the one hand, it must be remembered that the crenation of the red-blood corpuscles is a phenomenon that habitually ensues upon the withdrawal of blood from the healthy human body. It occurs at a period which varies in accordance with variations in the method in which the specimen is treated, such as the violence with which it is handled, the degree of exposure to atmospheric air, &c., and which is probably also modified by variations in the specific gravity of the serum as much as by the vitality of the blood corpuscles. In the present state of our knowledge we must regard this process, in any case, as one of the first manifestations of departing vitality in the red-blood corpuscles, and therefore it seems reasonable enough to suppose that in yellow fever, perhaps also in all diseases in which observation shows that putrefaction occurs unusually soon after death, this change would occur at an earlier period after the withdrawal of the blood from the body than happens in normal blood; and particularly that this would be the case with blood drawn from malignant cases shortly before death. But reasonable enough as this appears, the evidence does not satisfy me that it actually happens, and further researches should, I think, be made by some one who has first found time to study in a more thorough manner than has yet been done the phenomena of the crenation of the colored corpuscles in healthy individuals and in other diseases.

As for the old speculation to which Haenisch has again given voice, that the fatty degenerations, hæmorrhages, and other lesions of this disease are due to a previous destruction of the red corpuscles occurring on such a scale as to cause the blood "to lose its capacity for nourishing the tissues of the body in the normal way," I have not been able to hear of any observer who has undertaken to test it by any of the recently devised ingenious plans for estimating the number of corpuscles in a measured quantity of definitely diluted blood by actual count;* and I would specify this as one of the investigations which should be undertaken, for surely if an actual breaking up of the red corpsucles of the blood has anything whatever to do with the pathology of this disease, it would be possible to establish the fact of their diminished number, in the latter stages of the diseases at least, by an actual count.

Can any changes be observed with the microscope in the white corpuscles of the blood of those suffering with yellow fever? This question does not appear to have attracted attention until quite recently, and even among the latest observers several, like Dr. H. D. Schmidt, declare that nothing especially abnormal could be discovered by them in these elements. On the other hand, Dr. Joseph Jones describes the colorless as well as the colored corpsucles as presenting "a distinctly granular appearance, wholly unlike the conditions of these constituents in healthy blood;" and Surgeon G. M. Sternberg has observed in many of the white corpuscles of yellow-fever blood certain highly refractive granules, which he interprets as fat, and regards as representing a fatty degeneration of these cells. Surgeon Sternberg, it is true, as I myself have done, has found similar granules in the white blood corpusoles of healthy individuals. But in this case the number of granules in each corpuscle was small, and the process was absent from the great majority of the globules, "while in severe cases of yellow fever the granules were abundant, and nearly every white corpuscle contained some of them." These statements are well supported by Surgeon's Sternberg's photographs; so that the facts may be regarded as established for the cases observed, but further researches appear to be required to indicate the full significance of this observation.

Dr. J. Crevaux, who does not mention the conditions just described, testifies that he found in the blood of yellow-fever patients a greater number of fatty globules than occur in the physiological condition. Guichet makes a similar observation, and Dr. Joseph Jones has stated, on the basis of chemical analysis, that there is an increased percentage of fatty matters in the blood of this disease. Shall we conclude from this testimony a fatty degeneracy of the blood; and, if so, is it peculiar to yellow fever, or does it occur also in typhus and other malignant fevers? Besides the further investigation of these questions, inquiries are needed as to whether any changes can be observed in the structural details of the protoplasm of the white corpuscle in this disease; and also as to whether in the duration of their amœboid motion on the warm stage, or in other particulars, any noteworthy alteration in their vital manifestations can be observed.

Can the microscope discover in the blood of yellow fever any low vegetable forms, or other bodies which may be supposed to be related to the materies morbi? Dr. Joseph Jones and Dr. J. G. Richardson of Philadelphia, have made observations that appear to favor an affirmative answer to this question. Dr. Jones states that he observed in the freshly-drawn blood of a yellow-fever patient "minute oval bodies with a central nucleus," similar in size and appearance to those he found in water through which the air of "yellow-fever rooms" had been passed. He also states that he has seen "bacteria and delicate thread-like filaments" in the blood and urine of yellow-fever patients, and similar ones in "the water from yellow-fever rooms."

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*See "La Roche," Vol. I, p. 171. To avoid repetitions, I shall not, as a rule, give references to the authorities cited in this paper, but will append a list of the several books and essays referred to.

†It is to be inferred that these examinations were always made in the manner described in connection with the observation here cited: "I hastened to my laboratory with the blood of the patient, which had been received into glass-stoppered bottles, chemically clean, and which had never been used before, and submitted the blood to microscopical examination." See the first essay of Dr. Jones, cited in the appended list, p. 952.

*For this purpose the hémetomètre of MM. Hayem and Nachet, the hæmacytometer of Graves, or the similar apparatus made by Zeiss (of Jena) may be used; only in any case care should be taken to carry the count far enough to obtain a definite result. On this subject consult E. Abbe, Ueber Blutkörper-Zählung, Sitzungsberichten der Jenaischen Gesellschaft für Medicin und Naturwissenschaft. Sitzung vom 29 November, 1876.

At the Richmond meeting of the American Public Health Association, in November, 1878, Dr. Richardson is reported to have said that he found many dumb-bell-shaped bacteria (which he proposes to call B. sanguinis) in the blood of yellow-fever patients sent to him hermetically sealed. On the other hand, while the presence of such bodies is ignored by Crevaux, Guichet, and others who have recently examined yellow-fever blood with the microscope, Dr. H. D. Schmidt testifies that he was unable to discover "a single bacterium or spore of a fungus," although he "honestly endeavored to do so." Surgeon Sternberg likewise, in his examination of the blood of yellow-fever patients at Havana in 1879, entirely failed to discover low vegetable forms in any freshly-drawn specimen, although he states that in some (not all) of the samples he preserved for a time in culture cells "hypomycetus fungi, and spherical bacteria made their appearance after an interval of from one to seven days;" these he believes, for reasons which appear conclusive, to have originated from the accidental admixture of atmospheric germs. In this condition the question remains at the present time. Certainly there is room here for further careful observation, and although I confess that I am not sanguine that it will yield other than negative results, I think the subject ought not to be neglected in future work.

2. *The black vomit.*—That the black vomit owes its characteristic appearance to the admixture of blood was long ago established by the observations of numerous microscopists, who have also, as is well known, observed epithelial cells, oil globules, and divers débris of food. The chief interest at present connected with the study of this excretion centers in the question: *Can any low vegetable forms that may possibly be connected with the causation of yellow fever be discovered in the black vomit?* The question of the presence of low animal forms, raised by Rhees in 1820, had already been thoroughly disposed of when La Roche wrote, and needs no discussion in this place.

Already, at that time also, the question of the presence of characteristic low vegetable forms had been brought into notice, especially by the descriptions and figures of Hassall, but as the branching fungus described by this microscopist was found in a sample of black vomit examined some time after its evacuation, and as similar forms have not since been observed, no importance can be attached to it. Among recent observers, Dr. Joseph Jones states that he has found great numbers of bacteria, micrococci, and other low vegetable forms in black vomit examined immediately after its ejection.* Dr. H. D. Schmidt, on the other hand, declares that the vegetable form he most commonly found in the recent vomit was "the so-called yeast-plant, or torula cerevisiæ," though he adds that other fungi will develop if the specimen is left standing, "as these fungi get into the stomach with the food or the air swallowed." He remarks: "They have no relation to the cause of the disease. I still regret the time which I have spent in their cultivation, as I might have applied it to more practical examinations." A significant remark, and yet, I suppose, in the present condition of the vexed questions connected with the germ theory of disease, it is still desirable to press inquiries in this direction also; but such inquiries, to be fruitful, must be made by an observer who is well acquainted, on the one hand, with the botanical families to which any forms that may be discovered in the black vomit belong, and, on the other hand, with the forms that normally occur abundantly in many parts of the alimentary canal, and with the conditions that may lead to their appearance in the stomach also. Moreover, in all such inquiries, we must be careful to distinguish between what is found in the black vomit remaining in the stomach after death, and first examined after the autopsy some hours later, and that which can be observed in the vomit ejected during the life of the patient and immediately examined. The importance of this discrimination is well illustrated by the statement of Surgeon Sternberg, that the black vomit ejected during life contains scarcely any cylindrical epithelial cells from the gastric mucous membrane, while that found in the stomach after death contains them in large numbers, an observation which corresponds perfectly with what is known of the occurrence of columnar cells from the intestinal epithelium in the rice-water discharges of cholera.

The urine.—Two questions of interest require further microscopical examination in connection with the urine in yellow fever. The first is raised by the statement of Dr. Joseph Jones, already mentioned, that he has observed "bacteria and delicate thread-like filaments" in the urine of yellow-fever patients, as well as in the blood and in the air of the sick-rooms. So far as I know, this statement is not supported by the observations of any other credible observer, but it is not on that account to be cast aside in the present state of our knowledge without further question. It seems desirable that this part of the general question of the imagined relation of yellow fever to vegetable germs pre-existing in the air should also be considered by competent observers in connection with similar inquiries with regard to the blood, the vomited matters, the tissues of the dead body, and, finally, the air itself. In connection with such examinations of the urine, however, the great rapidity with which micrococci, bacteria, and penicilium develop in this fluid in hot weather, and particularly the rapidity with which micrococci and bacteria develop under such circumstances in albuminous urine, should be steadily borne in mind.

The second question relates to the histological characters of the epithelial cells and tube-casts found in the urine; the morphology of the latter being especially important in connection with the interpretation of the structural lesions of the kidneys found after death. Notwithstanding certain negative statements, the fact of the frequent occurrence of tube-casts in the urine during the albuminuria of yellow fever appears to be established by the testimony of several competent observers. We need, however, more definite details than we yet possess with regard to their characters and the circumstances of their appearance. The most detailed information on these heads, so far as I know, has been given by Lawson, who states that about the fourth day of the disease a copious deposit of pavement epithelium from the bladder makes its appearance in the urine. On the fifth day this is replaced by a copious deposit "composed of granular tube-casts from the kidneys," 1 to 1.3 thousandths of an inch in diameter, with sometimes an admixture of the "solid transparent casts called waxy." After the sixth day the casts found are more and more hyaline, and if the patient survives a few days longer they entirely disappear. Somewhat less detailed is the description of the casts observed in the urine of some yellow-fever patients at Louisville, Ky., during the fall of 1878, which has been published by Dr. J. W. Holland of that city; but it has the advantage of being accompanied by a plate representing the appearances observed. The observations of Dr. Holland closely correspond with those of Lawson. On the third day in several cases, before the appearance of albumen in the urine, he found epithelial cells from the bladder, and "spindle-shaped cells probably from pelvis of kidney." The same forms were also sparingly found at a later period in some mild cases in which albuminuria was at no time present. After the fourth day, in severe cases, the urine became albuminous, and tube-casts made their appearance; they were "highly, moderately, and slightly granular," and "some have epithelium embedded." The granular part of these casts is probably "made of the disorganized cellular lining" of the kidney-tubules, the clear portion of "the mucoid matter of Beale." Some of them are from the straight, others evidently from the convoluted portion of the tubules. In a single case only were unmistakable waxy casts found. These are, so far as I know, the only observers whose descriptions of the tube-casts are at all definite, or who have attempted to connect their appearances and characters with the stages of the disease in which they occur. It is evident that there is room in this direction for much further study, and especially that the relations in morphology and composition between the casts seen in the urine during life with those found in the kidneys after death should be made the subject of critical study.

B.—HISTOLOGICAL INVESTIGATIONS OF DISEASED TISSUES AND ORGANS.

Under this heading I shall discuss especially the lesions hitherto discovered in the nervous centers, the heart and bloodvessels, the stomach, the liver, and the kidneys.

1. *The nervous centers.*—The prominence of nervous symptoms in certain forms of yellow fever, as well as the speculative views of those who suppose the yellow-fever poison to act primarily upon some part of the nervous system, have led to many vain efforts to discover characteristic lesions in the cerebro-spinal axis, or the sympathetic ganglia.

Cerebro-spinal axis.—Already in the accounts of the older dissections we read of the occasional occurrence of congestion and œdema of the brain and its membranes, and similar appearances have been noted in the spinal marrow and its membranes, particularly in their lower portion. Ecchymosed spots have also been observed on the surface of these as well as of other internal organs. But none of these appearances are constant, and it has become evident that histological research alone affords any promise of further information in this direction. Yet the histological investigations hitherto undertaken have contributed very little to our knowledge; nor is this surprising, for it is precisely in connection with the nervous centers that our notions of normal histology and of the minute changes occurring in other diseases is most imperfect, the soft and delicate tissues of these organs presenting special difficulties to the investigator. Lawson alone has recorded microscopical appearances which suggest the idea of a commencing meningitis in cases characterized by well-marked head symptoms. In such cases he states that he found "large exudation corpuscles" in the white matter "near the surface of the hemispheres," and that the nuclei in the walls of the minute bloodvessels were abnormally numerous. On the other hand, Gama Lobo, who made, during the Brazilian epidemic of 1873–'74, three autopsies, in which considerable cerebral congestion was observed, is reported by Rey to have found no other morbid process than fatty degeneration, involving especially the cerebral cells and the walls of the cerebral capillaries. Dr. H. D. Schmidt observed similar conditions at New Orleans during the epidemic of 1878. He relates that he found fatty degeneration of the "ganglionic bodies" of the cortex cerebri, and of the nuclei of the walls of the minute vessels ("venules as well as arterioles") of the pia mater, and of the cortex cerebri. In many vessels the nuclei had disappeared, leaving a number of fat globules in their places. At the same time, others were met with in which there was

* "The black vomit was conveyed immediately to my laboratory and subjected to chemical and microscopical examination. * * * The whole mass literally swarmed with bacteria, micrococci, spirillum undula, vibro serpens, spirochæte plicatitis, spirochaete obermeii, spirillum tenue, micrococci, and delicate dichotoma threads, and the thallus of a delicate fungus, the diameter of which did not exceed one ten-thousandth of an inch." See p. 953 of the first paper of Dr. Jones, cited in the appended list.

an increase of the protoplasm surrounding the nuclei in the normal condition, causing a thickening of the walls of the vessels, and giving rise "to minute aneurisms, and a final rupture of the vessel." Besides this he observed, in almost all the cases examined, an exudation of finely-granular matter in the subarachnoid space, and filling up the meshes of the pia mater.*

So far as I know, the foregoing are the only structural lesions believed to have been observed by microscopists in the cerebro-spinal axis of subjects dead of yellow fever. Knowing the difficulties that surround such investigations, I feel compelled to receive them with a certain reserve, although certainly the fatty degeneration described by Gama Lobo and Schmidt seems consistent enough with what we know of the other lesions in this disease. In further investigations the true nature of the apprearances supposed to indicate the existence of fatty degeneration in the parts under consideration should certainly be tested on perfectly fresh specimens by the action of suitable reagents, such as osmic acid especially, and after the appearances observable without reagents have been carefully noted. The results thus obtainable are absolutely necessary for the interpretation of the lesions observed, or supposed to be observed, in sections of hardened portions.

Among the pathological specimens forwarded to me for examination were several pieces of spinal cord; and Dr. McConnell cut sections from the lumbar region of the two which appeared best preserved. In all these sections I found a peculiar abnormal condition, which I think necessary to mention, although I have grave doubts as to whether it can be regarded as a lesion produced by yellow fever. Scattered through all parts of the sections, but most abundant in the white matter of the cord, there were considerable numbers of peculiar rounded or oval bodies, from two to five-thousandths of an inch or more in long diameter. They appeared under a two-thirds objective, in the balsam-mounted sections, as colorless spaces, empty, or filled with delicately-granular contents. With a good immersion lens (one-fourth to one-eighth) the granular character of the masses was more distinctly seen, and some of them appeared to be encapsuled with a layer of nucleated connective tissue resembling condensed or compressed neuroglia.

With regard to the actual significance of these bodies, I am not prepared to offer any positive opinion at the present time. If they are the product of a degenerative change taking place during life, the process is certainly not peculiar to yellow fever. They appear to be very like the granular masses sometimes found in thin sections of the brains of the insane, as shown in some of the microphotographs reproduced and described by Dr. John P. Gray in 1874.† Similar appearances in the spinal cord have been figured by Dr. E. L. Fox, in a plate labeled "Gray degeneration of the cord."‡ I may add that there are in the microscopical cabinet of the Army Medical Museum sections of the brain of a man dead of tetanus, and of the spinal cord of a horse dead of epidemic catarrh, in which there are numerous rounded or oval bodies identical in appearance with those found in the sections of cord from the yellow fever cases; and the same is true of some sections, in the same collection, of the spinal cord of an apparently healthy cat, killed for dissection.

I entertain a strong suspicion that in many cases such bodies as these are merely the result of post-mortem changes, and have no pathological significance, but am not now prepared to insist upon this view, to establish or disprove which would require a somewhat laborious series of experiments.

The sympathetic ganglia.—Dr. S. A. Cartwright of Natchez claimed in 1826 the merit of the "discovery" that in yellow fever the delicate tissues involving the whole ganglionic system of nerves were more or less inflamed. He asserted that he had found this condition in the cardiac, pulmonary, mesenteric, renal, and hepatic plexuses, but that "the semilunar ganglions and the cœliac plexus were in particular highly diseased." Dr. C. Belot of Havana in 1865, revived this statement, so far as the ganglia of the solar and cœliac plexuses were concerned, with the additional remark that he found them softer than normal, so that when compressed between the fingers they were easily mashed.

These assertions have served to suggest the microscopical examination of the sympathetic ganglia. Dr. Schmidt reports that he has made and examined thin sections of some of these ganglia in five cases. "The ganglia chosen for examination were those of the solar plexus, especially the semilunar, together with the first thoracic, or ganglion stellatum." In two cases he found that the nuclei of the ganglion-cells had "disappeared, though the nucleoli were left behind"; and he thinks this was probably due to fatty degeneration. In another case there was an abnormal accumulation of pigment in the ganglion-cells; in the rest he detected nothing abnormal. As for the minute bloodvessels, although they were congested in some cases, they were empty in others.

Dr. J. Guiteras, of the Havana Commission, examined the semilunar ganglion microscopically in three cases, and reports that he found cloudy swelling of the nervous elements, and that "connective tissue of new formation" was met with to a still greater extent than in the liver and kidneys of the subjects he dissected.

Among the balsam-mounted preparations by this gentleman I found several carmine-stained sections of the semilunar ganglia of subjects dead of yellow fever, which show the structural details quite well. These I have examined with care, and critically compared with some sections prepared by Dr. McConnell, at the museum, from the semilunar ganglia of human subjects dead of other diseases. This comparison has forced me to the opinion that the preparations of Dr. Guiteras do not really exhibit any abnormal condition. It is well known that the individual nerve cells of each lobule of the large sympathetic ganglion are held together by a dense connective tissue, which, indeed, has been described as forming a separate capsule for each nerve cell. In balsam-mounted sections of such lobules, large numbers of oval nuclei belonging to this connective tissue can be observed; but these appeared to be quite as numerous in the sections prepared at the museum as in those from the yellow-fever subjects. Moreover, the indistinctness of the nuclei of the ganglion-cells, mentioned by Dr. Schmidt, did not exist in the preparations of Dr. Guiteras. These nuclei appeared to me fully as distinct as the nucleoli, and both were readily defined with an immersion one-fourth, wherever the sections were thin enough to give a satisfactory view of the cells.

2. *The heart and blood-vessels.*—A fatty degeneration of the muscular fibres of the heart was described by Professor Riddell, of New Orleans, in his account of the microscopical observations made by him during the epidemic of 1853.* This condition has since then been emphasized by several investigators, among whom I may mention especially Dr. Joseph Jones and Gama Lobo, but others have failed to recognize it. Lawson declares that he never saw an instance of it, but he did not regard the condition of the cardiac muscle as normal. He found the fibres pale, with indistinct transverse striæ, and an abnormal disposition to separate longitudinally into their component fibrillæ; there was also a certain haziness or loss of definition in outline, affecting both the fibers and the bloodvessels between them, and he thought he recognized the presence of an exudation in the cardiac tissue similar to that he believed to exist in the kidneys, liver, and brain. J. Crevaux in 41 autopsies, made very soon after death, found the heart quite firm in 39. Four of these cases he examined microscopically, but sought in vain for any traces of fatty degeneration; on the contrary, the transverse striae were perfectly distinct. In like manner Dr. J. Guiteras was unable to discover this lesion in any of the autopsies he made at Havana. He found the heart normal in consistency and color, its striations always distinct, and only in some of the fibres were a few fatty granules seen in the neighborhood of the nuclei. I may remark that the striations of the cardiac muscular fibres are very plainly seen on several of the balsam-mounted preparations made by this gentleman, and that none of them exhibit any appearances which can be interpreted as due to fatty degeneration. This lesion, therefore, cannot be regarded as by any means constantly present in yellow fever, but this by no means proves that it does not occur in certain cases, perhaps in certain groups of cases; only the unskilled observer must be careful not to mistake for it the granular appearance produced by cardiac changes, and must bear in mind that the transverse striations of the cardiac fibres are normally less distinct than those of the voluntary muscles, as well as the circumstance observed by Kölliker, that small fat granules in the vicinity of the nuclei are habitually found in the cardiac fibres after death.†

Certain lesions are also said to have been recognized with the microscope in the minute bloodvessels. It is well known that one of the characteristic features of this disease is the marked tendency to hæmorrhages. Besides external hæmorrhages, such as black vomit, bloody sputa, bloody urine, &c.; internal hæmorrhages are of frequent occurrence. They are found in the form of apoplectic infarctions of the lungs, the intermuscular connective tissue, &c.; but still more frequently as minute hæmorrhagic spots, resembling petechiæ or ecchymoses on the surface of various internal organs, or scattered through their parenchyma. It seems to be pretty clear that the appearances last mentioned, as well as the others, are due to actual hæmorrhages, and not merely to a transudation of the coloring matter of the blood; but the nature of the abnormal condition of the vascular wall that favors these hæmorrhages is by no means established. The statement of Lawson that in various other organs, as well as the brain, the nuclei of the walls of the minute bloodvessels are abnormally numerous has not been supported by subsequent observers. More probable appear the accounts of those who, like Crevaux, Gama Lobo, and Schmidt, believe they have observed a fatty degeneration of the walls of the capillaries and small vessels of this or that organ. This view agrees with the general belief in a tendency to fatty degeneration in various other organs, especially the heart; but the accounts referred to are by no means so complete that they can be regarded as settling the question, so that further researches are desirable.

3. *The stomach.*—The stomach of subjects dead of yellow fever usually contains a greater or less amount of black vomit, and the microscopical examination of this fluid is the more important because the columnar epithelium of the gastric mucous membrane desquamates so soon after death that in most cases the condition of its

*I understand from the context that all these observations were made only on preparations hardened first in bichromate of potassa.

†JOHN P. GRAY. *Pathology of insanity*, Amer. Jour. of Insanity, July, 1874, p. 1. I refer particularly to Plate A, Figs. 1 and 2, Plate C, Fig. 2, and Plate E, Fig. 2.

‡E. L. FOX. *The pathological anatomy of the nervous centers*, London, 1874. Plate VIII, p. 114.

* LA ROCHE, vol. I, 392.

†A. KÖLLIKER—A *Manual of Human Microscopic Anatomy*, London, 1860, p. 478.

elements can only be observed by examining the fluid contents of the organ. Although it has been stated that occasionally the mucous surface of the stomach presents no abnormal appearance, or is even paler than natural, yet in the great majority of yellow-fever cases it is more or less congested, often intensely so; ecchymotic spots are frequently observed on its surface, occasionally hæmorrhagic erosions, and even it is said ulcerations. The nature of the process giving rise to these appearances has been the subject of some discussion. The most generally accepted view, based in part upon what is seen by the unaided eye, in part upon the symptoms of the disease, is that we have here to do with an acute gastric catarrh of variable intensity; but the correctness of this view is by no means so fully supported by exact histological observations as could be desired. Indeed, several of the most recent investigations appear to be opposed to this view. Among these may be mentioned those of J. Crevaux, according to whom the most important lesion is a fatty degeneration of the cells that line the gastric glands and of the capillaries of the mucous membrane. By the latter lesion he explains the hæmorrhage that gives the black vomit its character.

The appearances observed by Dr. Schmidt are interpreted by him as representing simply a venous congestion, the consequence of previous disturbance in the circulation of the liver. He has given some interesting details with regard to this congestion. It is well known that the mucous membrane of the stomach is the seat of a fine capillary network, the meshes of which surround each of the several gland-tubes. These empty into a fine plexus of venules situated near the surface of the mucous membrane, just beneath its epithelium. From this plexus, at intervals, rather larger veins originate which descend perpendicularly between the gastric glands to join the plexus of still larger vessels in the submucosa.* Now, according to Dr. Schmidt, the congestion of the gastric mucous membrane is seated in the superficial venous plexus; it is not uniformly diffused, but exhibits numerous small red centres or spots corresponding to little territories immediately around the places at which the small veins just mentioned descend perpendicularly through the mucous membrane. The centres of congestion he regards as undoubtedly the spots from which "the hæmorrhages known as black vomit proceed." He mentions further that he observed free hæmoglobulin in the "epithelial and glandular cells" surrounding the congested venous radicles. Dr. J. Guiteras declares as the result of his observations that "the stomach presents no evidences of inflammation. The protoplasm of the epithelial cells is normal, and the nuclei quite distinct." Having made his autopsies so long after death, he not unnaturally complains that he found in most of his preparations that "the tops of the ridges between the gastric follicles are removed by post-mortem digestion." In some of them, however, these ridges remained, and then he detected in them small hæmorrhagic infarctions close under the free surface of the mucous membrane. Dr. T. E. Satterthwaite, however, who exhibited last October to the New York pathological society a number of microscopic slides from a woman who died of yellow fever at the Presbyterian hospital, July 29, 1879, is reported to have observed in the stomach-sections appearances corresponding in some particulars to those that occur in gastric catarrh: "The epithelia of the mucous and peptic glands were thought to be abnormally granular. At the mouth of the follicles the epithelium was frequently wanting, and in them were seen in places lymphoid corpuscles. There was neither congestion of the stomach nor extravasation of blood. The connective tissue seemed increased in amount."

From an examination of the sections mounted by Dr. Guiteras, and of those prepared from the fragments of stomach received at the Museum, I can fully corroborate the statement of that gentleman that all these specimens had suffered more or less from post-mortem changes. The distribution of the venous congestion, so far as it could be made out, corresponded closely to the description given by Dr. Schmidt. If such changes as fatty degeneration of the capillaries of the mucous membrane or of the cells lining the tubular glands had existed, they were no longer recognizable, and, except in two particulars, the sections did not appear to differ from those cut from normal stomachs in which post-mortem changes have fairly set in. The first was the characteristic congestion, the second was the presence in some of the sections of a number of elements resembling wandering white-blood corpuscles. The latter were seen in the vicinity of some of the veins descending perpendicularly through the mucous membrane, and group-wise in other places, especially toward the bases of the tubular glands. These observations are, of course, entirely inadequate to determine the frequency and significance of the lesion just named; and it may be added that none of the researches hitherto reported deal satisfactorily with the question of the changes occurring in the gastric mucous membrane, except so far as concerns the anatomical relations of the congestion that determines the gastric hæmorrhage, so that the whole subject of the histological conditions of the mucous membrane itself requires further investigation.

4. *The liver.*—Since the publication of the observations of our fellow-countrymen, Drs. Alonzo Clark, T. H. Bache, and Joseph Leidy,† the hepatic lesion in yellow fever has been most generally regarded as essentially a fatty degeneration of the organ. Dr. Leidy compared the condition of the hepatic cells to that observed in the fatty livers of drunkards and consumptives. They "were unaltered in form and structure from the normal condition; but they differed in having deposited in their interior a variable amount of oil globules, frequently entirely obscuring the nucleus, which, however, was rendered readily visible on the application of acetic acid. The oil globules varied in size from a small granule to the one-half the diameter of the containing cells, and many of those observed loose in the field of the microscope, which had escaped from lacerated cells, ran together and formed drops larger than the cells." Those subsequent observers who have not contented themselves merely with recognizing this condition may be divided into two groups: The first have endeavored to make out the preliminary morbid processes that precede the fatty metamorphosis; while the second have thought they observed in the advanced stages of the disease certain additional characteristic changes.

That the fatty degeneration of the liver is a lesion developed after the commencement of the disease seems to be pretty well established, as is also the circumstance that the degree to which it is present at any given stage of the fever varies in different individuals and different epidemics. The livers studied by Dr. Leidy were described by him as varying in color from a "yellow clay-like hue to a brownish-orange;" but other equally careful observers have described yellow-fever livers as brown, chocolate color, or the color of café au lait, and between these hues and the brighter yellows various intermediate tints have been noticed. In yet other cases the liver has been found purple, livid, or engorged with blood; and the assertion of some of the older observers that it may even exhibit no recognizable deviation from its normal color and texture has been repeated from time to time to the present day.* It may, perhaps, be doubted whether these apparently normal livers would have sustained the test of careful histological examination, but the occasional occurrence of a highly congested state of the organ is supported by some of the most recent anatomical investigations. Thus, J. Crevaux, during the epidemic of 1877 in French Guiana, found, particularly in cases that died very early, manifest congestion of the parenchyma of the liver, accompanied by ecchymotic spots on its surface. Microscopical examination showed that this congestion had its seat in the interlobular (portal) veins, and not, as in the so-called "nutmeg liver," in the intralobular (hepatic) veins. When death took place later in the disease, however, he always found the liver more or less yellowish, and then its parenchyma exhibited under the microscope a corresponding degree of fatty degeneration. He concluded, therefore, that in the ordinary course of yellow fever a stage of congestion precedes the fatty degeneration of the organ.

This view, which has been accepted by Bérenger-Féraud and other subsequent writers, is supported by some of the observations of Dr. H. D. Schmidt, who states that in epidemics previous to that of 1878 he has sometimes observed parts of the liver congested, while other parts were fatty, and others even normal. The congestion was usually confined to the interlobular vessels, but he observed the "nutmeg" condition also in a limited number of cases. In the autopsies he made during 1878, however, he invariably found the whole liver fatty, and usually in a high degree. Dr. Schmidt, however, describes certain particulars in which the yellow-fever liver differs from the common fatty liver. Although he made his autopsies quite soon after death (three-quarters of an hour to three or four hours), he noticed that the hepatic cells were stained by carmine and other coloring matters with difficulty, and this he attributes to a "commencing degeneration of their protoplasm;" moreover, he states that he recognized the presence of extravasated hæmoglobulin, with or without associated bile-pigment, in the hepatic cells, "in the vicinity of the ultimate branches of the bloodvessels" of the organ.

Other observers, both earlier and later than he, have believed they detected with the microscope something more than mere fatty degeneration in the yellow-fever liver. Unfortunately, however, the testimony in this direction is by no means harmonious. Lawson, who recognized fatty degeneration of the liver in a part at least of his cases, held (1862) that there is in yellow fever an active exudation into the parenchyma of the organ, embracing the minute bile-ducts, and closing them to the passage of the bile. He also found the interlobular connective tissue abundant, opaline, and containing more or less exudation and granular matter, while the minute arteries and veins "were covered with closely-set nuclei and granules." With this account may be compared the brief description by Bonnet (published in the work of Bérenger-Féraud) of two microscopic sections of the liver of a patient who died of yellow fever during the epidemic of 1877 in French Guiana. They are said to have exhibited thickening and slight sclerosis of the perivascular connective tissue, while cloudy swelling (tuméfaction troublé) was uniformly associated with the fatty degeneration of the cells of the hepatic lobules. Still more marked were the lesions in the interlobular spaces observed by Le bredo in two livers sent in alcohol from Havana to Paris during the year 1877. Besides a fatty degeneration of the parenchyma of the

*See C. TOLDT in STRICKER'S *Manual of Histology*, Amer. Ed., New York, 1872, p. 403.

†LA ROCHE, Vol. I, p. 404.

*Thus, for example, Carl Heinemann remarks, "In gar nicht wenigen Fällen die Leber vollkommen frei von Veränderungen angetroffen wird." See p. 171 of his essay, cited at the close of this paper.

hepatic lobules, in which the capillaries were collapsed, and contained almost no blood, he found unmistakable evidences of the form of cirrhosis described by Charcot and Gombault under the designation of cirrhose en îlots.* He prudently regarded this cirrhosis as an ancient process, long antedating the fever; but conjectured that certain groups of leucocytes observed in the hypertrophied interlobular connective tissues, especially around the biliary canals, were evidences of an accute process occurring during the fever. In the case reported by Dr. T. E. Satterthwaite somewhat similar lesions were observed. Many of the liver cells were in an advanced stage of fatty degeneration, while others were more granular than normal, and it was with difficulty that any nucleus could be recognized. "There was also a marked increase in the connective tissue of the organ, and in places the separate cells were surrounded by new-formed connective tissue, as has been observed in syphilitic cirrhosis." Dr. J. Guiteras, of the Havana Commission, found one of the livers he examined affected with cirrhosis, which, however, he regarded as a pre-existing chronic process, holding that the lesion characteristic of the yellow-fever liver is "the so-called parenchymatous inflammation of Virchow. The hepatic cells are in a condition of cloudy swelling." At times, however, they show "evidences of fatty degeneration and pigmentary infiltration." Certain modifications in the connective tissue of the organ accompanied these changes; he thought it swollen, and that it presented some embryonal cells.

By yet another group of observers the hepatic lesion in this disease has been regarded as similar to that which characterizes acute yellow atrophy of the liver, or even as identical with it. This view was especially insisted on by Liebermeister in his essay on parenchymatous degeneration of the liver, although he admitted that it was by no means established by adequate microscopical observation. These Adolf Schmidtlein has attempted to supply from studies made in 1865 at Vera Cruz. He states that he found the hepatic cells quite destroyed, and, in this and other particulars, declares that the histological changes observed fully corresponded with those described by Liebermeister as occurring in acute yellow atrophy. With this statement may be associated the observations recently reported by Guichet. This military surgeon brought back from Madrid, in 1878, pieces of two yellow-fever livers, which were investigated by M. Sabourin in the laboratory of Professor Charcot.† M. Sabourin reports that he found the hepatic cells affected by two intimately-associated lesions: 1. Fatty degeneration. 2. "Fragmentation granuleuse." The latter process (which, according to him, is the most important, the former being only accessory to it) he describes as follows: "The protoplasm of the cell breaks up (*se fragmente*) into several irregular blocks, which refract light a little more than the normal protoplasm; then the nucleus of the cell disappears." The ultimate result is to convert the lobule into a "magma" of fragments.‡ Simultaneously a certain number of the cells undergo the process of ordinary fatty degeneration, being ultimately transformed into vesicles filled with oil, and in stained preparations the peripheral nuclei of these vesicles, as well as the nuclei of the hepatic capillaries, can be recognized in the midst of the magma of fragments mentioned above.

Two of the observers cited have recognized, in addition to the lesions described, the presence of small collections of bacteria in sections of yellow-fever livers. Dr. Schmidt relates that he found them only in the cuts from a single piece of liver, which he afterwards remembered he had found floating in the solution of bichromate of potassa employed to harden it. He attributes the floating of the piece to germs developed by commencing putrefaction, and supposes the bacteria to have been developed at the same time. Dr. Satterthwaite is reported as stating that in sections of the liver he examined "collections of bright little bodies of uniform size" were found. "They were bacteria and seemed to be in the blood-vessels." According to the report of his remarks, "It was stated by Dr. Satterthwaite the presence of bacteria in the specimens could be explained in various ways, and he did not believe that it in any way sustained the notion that these organisms produced the disease. Accumulations of bacteria of similar appearance he had found in persons suffering from other diseases not contagious or infectious." It should be added that Dr. Guiteras, of the Havana Commission, sought in vain for low organisms in the specimens he examined. "No microphytes have been found," he writes, "in the liver or the blood contained in its vessels."

I do not feel myself in a position to submit the foregoing diverse accounts of the hepatic lesions in yellow fever to a criticism guided by personal observations, and must content myself therefore in this place with a brief statement of what I was actually able to observe in the sections mounted by Dr. Guiteras and those prepared at the Army Medical Museum from the pieces of yellow-fever livers sent me for examination. So far as I was able to observe, the most prominent lesion exhibited in the majority of these sections was fatty degeneration of the cells of the hepatic parenchyma. In the balsam-mounted specimens, it is true that the fat, which had been dissolved out by the previous action of alcohol and benzole, was no longer visible as such, but the characteristic vacuoles left after its solution were readily observed in almost all the cells examined, and did not differ in appearance from those seen in sections of ordinary fatty livers similarly prepared. The stage to which this fatty degeneration had advanced differed somewhat in the several livers examined, but in none of them had it attained a very high degree. The cells usually contained from one to six or eight vacuoles, the largest of which seldom much exceeded the cell-nucleus in size; rarely did I see cells occupied by a single colossal vacuole, such as are so commonly observed in balsam-mounted sections of livers in which the process of fatty degeneration is far advanced. The protoplasm between the vacuoles in the individual hepatic cells was reduced in quantity in proportion to the number and size of the vacuoles. It was yellowish in color, and seemed to break and tear very easily, at least the number of broken cells at the edges and in thin portions of the sections was larger than in ordinary fatty livers; but the lines of fracture seemed to be determined only by the arrangement of the vacuoles, and I could recognize nothing corresponding to Sabourin's description of "fragmentation granuleuse." The arrangement of the hepatic cells in chains radiating from the central venous radicle to the periphery of the lobule was not as clearly displayed as usual, and the preparations exhibited throughout a certain indistinctness closely resembling the familiar alterations of incipient putrefaction; moreover all the sections were found to be very difficult to stain with carmine, and in some of them no discrimination of the nuclei could be obtained in this way, another particular corresponding with the ordinary putrefactive processes. I readily verified in the sections prepared by Dr. Guiteras his statement that one of the livers he had examined was affected by chronic cirrhosis, and among the pieces of liver transmitted to me I found one from another case that exhibited the same lesion in a still higher degree. In both these livers the cells of the hepatic parenchyma presented conditions very similar to those just described, and in addition to this, in both an abundant infiltration of cells resembling leucocytes was observed, not merely in the abnormally developed interlobular connective tissue, but also in the parenchyma of the lobules. Except in these two livers, however, I was quite unable to recognize any pathological condition of the interlobular connective tissue, or of the vessels and bile-ducts imbedded in it. I found no infiltration of cells resembling leucocytes either here or in the hepatic parenchyma; nor did I succeed in discovering low vegetable forms in the bloodvessels or other parts of any of the sections. Evidently these observations are quite insufficient to solve the vexed questions relating to the hepatic lesions in yellow fever. According to a memorandum transmitted with the specimens, the patients from whom they were derived all died on the fourth, fifth or sixth day of the disease.* No written memorandum of the appearances of the livers was furnished, but I was told verbally by Surgeon Sternberg that they all presented the *café-au-lait* color. Marked fatty degeneration had occurred in them all, and they therefore throw no light on the morbid conditions that antedate this change. On the other hand, the extent to which the fatty degeneration had advanced in these livers affords evidently no indication with regard to the possible degree of the process in the livers of more protracted or more malignant cases.

As for the important questions relating to the associated lesions by which the yellow-fever liver probably differs from the ordinary fatty liver, I do not believe they could be solved merely by the study of sections made from pieces hardened in alcohol or other preservative fluids, even if the autopsies that furnished the specimens were made immediately after death. Is the yellow color of the protoplasm of the hepatic cells due to biliary coloring matter, the coloring matter of the blood, or both? Is the alleged fragmentation of this protoplasm a mere post mortem change, or a process that can be fairly recognized in livers examined immediately after death? Can any other abnormal changes than these heretofore described be observed in this organ? To answer these questions in a trustworthy manner will require not merely the investigation of fresh livers, as soon as possible after death, and a comparison of the appearances thus observed with those seen in carefully made sections from pieces of the same livers hardened in different ways, but it will be necessary to examine in this manner a considerable number of livers from subjects dying at different periods of the disease, including its earlier as well as its later stages, and probably to compare the conditions detected in those dead from endemic yellow fever with those found in the victims of severe epidemics. One further consideration, suggested by the previous literature of the subject, is emphasized by the specimens collected by the Havana Commission. It is very evident that yellow fever does not spare those who are already suffering with diseases of the liver, and, as these are of frequent occurrence in hot climates, the histologist who deals with the questions under consideration must be continually on his guard lest he confound lesions resulting from some pre-existing hepatic diseases with those dependent on the fever.

5. *The Kidneys.*—The great frequency of albuminuria in this disease has long directed attention to the condition of the kidneys;

* Charcot et Gombault. Contributions à l'étude anatomique des différentes formes de la cirrhose du foie. Archives de Physiologie, 1876, p. 453.

† A piece from a third liver was presented for examination to the laboratory of Vulpian. Fatty degeneration was recognized, but the piece was in such a state of cadaveric alteration that thorough investigation was impossible.

‡ This description closely resembles that of acute yellow atrophy of the liver by Cornil and Ranvier.—*Manuel d'Histologie Pathologique*, 3me partie, Paris, 1876, p. 889.

* Case 17 is said to have died on the third day, but I received neither mounted sections nor uncut fragments from the liver.

yet our knowledge of the minute changes in these organs is perhaps more incomplete than in the case of the liver and stomach; and the comparison with Bright's disease, early suggested by the mere fact of the presence of albumen in the urine, has added comparatively little to our knowledge, since, under this head, a variety of lesions are undoubtedly embraced. Alvarenga reports that in the Lisbon epidemic of 1857 the cortical substance of the kidneys was often found to be considerably swollen, and appeared to the naked eye to be fatty, as on microscopical examination proved to be the case. Haenisch remarks: "It is reported by almost every one that a swelling of the cortical substance, with partial fatty degeneration, is very often present." And in fact the general conception that the characteristic change in the kidneys, as in the liver and other organs, is a fatty degeneration has been pretty widely accepted.

Additional particulars, which are by no means fully accordant, have, however, been contributed from various sources. Lawson not merely found the epithelial cells of the tubuli very granular, their nuclei and outlines being indistinct, but thought the connective tissue of the organ seemed swollen and infiltrated with an opaline exudation. Moreover, the nuclei of the minute bloodvessels, including the loops of the Malpighian bodies, were abnormally numerous, and altogether he regarded the microscopical appearances as indicating "an active exudation into the parenchyma of the organ, and a catarrhal affection of its mucous surfaces." In one case he observed a deposit of pigment "in the form of minute granules," which covered the epithelium at intervals along the convoluted tubes. According to Dr. Joseph Jones, "when thin sections of the kidneys are examined under the microscope, the Malpighian corpuscles and tubuli uriniferi are found to be filled with granular albuminoid and fibroid matter, excreting cells detached and oil globules." J. Crevaux presents a view in harmony with his account of the pathological changes in the liver. When the duration of the disease has been short the kidneys are manifestly congested, and ecchymosed spots are observed in the cortical substance of the organ as well as beneath the capsule and on the mucous lining of its calyces and pelvis. In the cortical substance little globular hæmorrhagic spots the size of a pin's head were frequently observed, and turned out to be the capsules of the Malpighian bodies distended with blood. In one subject the central portion of some of these hæmorrhagic foci had softened into a pus-like fluid. Such little hæmorrhagic and purulent foci (*petits foyers sanguins ou purulents*) were observed by Chapuis more than twenty years ago in the kidneys of subjects dead of yellow fever. These preliminary lesions are succeeded by a fatty degeneration of the parenchyma of the organ. To the naked eye it appears of a whitish or grayish-yellow color; under the microscope the cells contain large oily globules and fine granules. According to Rey hæmorrhagic foci in the cortical substance of the kidney were observed also by Gama Lobo, in whose cases, however, they appear to have co-existed with fatty degeneration of therenal epithelium.

Dr. J. G. Richardson is reported to have found the uriniferous tubules of the kidney clogged with low vegetable forms. But the appearances on which this view was possibly based are differently interpreted by Dr. H. D. Schmidt, who regards the characteristic kidney lesion as a granular degeneration preceded by hyperæmia, and ultimately advancing to fatty degeneration. In some of the cases he examined, a few of the tubules were "blocked up by short albuminous cylinders of a yellow color." In other cases "the cells of the epithelium of the uriniferous tubules were observed to disintegrate, and the granules of the cells, set free by the degeneration of the protoplasm, to collect in opaque masses apparently held together by mucus." Dr. T. E. Satterthwaite is reported to have described the condition of the kidneys in the case examined by him as follows: "On microscopic examination the epithelium throughout the kidney was swollen and intensely granular. The tubes contained numerous small granular casts of a yellowish color. At the apices of the pyramids the collecting tubes were nearly stripped of epithelium. The epithelium that remained was intensely swollen, and even more granular than in other parts of the kidney. At several points the tubes, and in some cases the blood-vessels, were blocked with numerous little bright bodies of a uniform size, arranged in a regular manner at equal distances from one another. They looked at first like spherical bacteria, but on close examination with high powers (immersions 1–10, W. Wales, and No. 12 Prazmowski) the bodies proved to be mostly, if not wholly, rod-bacteria of the usual kind." In this connection it is proper to add that the patient died July 29, and that the autopsy is said to have been made twenty-one hours after death. Dr. J. Guiteras on the other hand reports that he found no organisms in the kidneys of the cases he examined at Havana. The cells of the renal epithelium were more or less in a state of cloudy swelling; but in every kidney some of the tubules appeared to be normal; in others he found evidences of catarrhal inflammation; not infrequently he observed yellow casts choking up the caliber of the tube; sometimes the tubules contained coagulated blood. The bloodvessels, especially of the cortex, were frequently distended with blood.

The appearances I was myself able to recognize in sections mounted by this gentleman and those prepared at the museum from the fragments of kidney submitted were, briefly, as follows: Not merely did the cells of the convoluted tubules in the cortical portion of the kidney appear to be swollen, and more than usually granular (how much of this latter condition was due to post-mortem change I know not), but in some of the sections the fact that fatty degeneration of the organ had commenced was clearly established by the presence in the protoplasm of these cells of the characteristic vacuoles from which the fat had been dissolved by the reagents used in preparing the sections for mounting in balsam. In some of these tubes the epithelial elements had become detached and lay free in the lumen. Others were occupied by one of two kinds of casts, yellow transparent ones resembling those called "waxy," and more or less coarsely-granular casts, the latter being by far the most numerous. In the cortical portion of the organ some of these casts, in the pyramids most of them, occupied the lumen of tubes, the epithelium of which was quite intact. The granular casts were certainly not collections of low vegetable forms, for, notwithstanding the length of time they had been immersed in alcohol, they dissolved, as did the waxy casts, in a solution of caustic potash. On the other hand it was very evident in some places that considerable numbers of red-blood corpuscles were imbedded in their substance, but in the condition of the specimens I was unable to form an opinion as to the actual share taken by mere hæmorrhage in their formation, or as to their relationship to the waxy casts, or to the detached epithelium observed in some of the convoluted tubes.

The two forms of casts observed in the tubules of the kidneys in these cases correspond with the descriptions of the two varieties found in the urine during life, and it is evident that the latter should be studied with the former. It will furthermore readily be understood that the remarks made in connection with the liver as to the importance of the further investigation of specimens taken as soon as possible after death in different stages and forms of the disease fully apply to the kidneys also. Among recent studies of the pathological histology of some of the ordinary forms of Bright's disease I may particularly mention the essays of T. Langhans, of Bern, and V. Cornil, of Paris,* as examples of fruitful researches which could not have been conducted had not fresh material been at the disposal of the investigators. Langhans obtained his best results by comparing the appearances observed in recent preparations macerated for a short time in bichromate of potassa, and teased out, with those seen in carefully made sections, while Cornil gave the preference to sections made from pieces of kidney hardened with osmic acid—a method which, as is well known, requires the freshest possible material to produce serviceable preparations. That the conclusions arrived at by these able histologists differ in so many important details may serve to illustrate the difficulties with which studies of this kind are beset; but I have been led by a perusal of the papers to the opinion that the methods of both should be included among those employed in the investigation of the yellow-fever kidney. The osmic-acid method is also to be commended as a means of determining with some precision the extent to which fatty degeneration has advanced in the renal epithelium, for which purpose it may advantageously be employed in the study of the liver and other parts affected, or supposed to be affected, by fatty degeneration.

Lesions observed in other organs.—It is not necessary for the purpose of the present paper to discuss the various other lesions that have been observed in this disease; they are, for the most part, either accidental concomitants of individual cases, or have been, as yet, so imperfectly studied that their significance is quite doubtful. As an illustration of the latter class of observations I may refer to the granular condition of the suprarenal bodies observed more than twenty years ago by Chapuis, and the fatty infiltration or degeneration of the same organs recently described by Dr. H. D. Schmidt.

CONCLUDING REMARKS.—Enough has been said, I trust, in the foregoing pages to show that we have yet a great deal to learn with regard to the pathological histology of yellow fever. The importance of further studies in other directions also, such as the chemical investigation of the blood and excreta, the microscopical and chemical investigation of the drinking water and the air, the accumulation of additional facts with regard to the circumstances under which the disease occurs, and the manner in which it spreads from place to place—all this is willingly conceded, but does not lessen in the least the urgent need of further histological studies to reconcile discordant observations and clear up so many doubtful points.

One further suggestion appears to be needed: It may be admitted that little or nothing is to be expected from additional autopsies in which the macroscopic appearances only are observed and recorded; but it is not for that reason unnecessary that these appearances should be critically noted whenever serious histological inquiries are to be undertaken; and under the same circumstances it is also important that the clinical phenomena should be studied with the greatest care. It is essential to our ultimate comprehension of the disease that the minute textural lesions of individual tissues and organs should be connected by actual observation with the changes recognizable by the naked eye, and with the several symptoms that

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*T. LANGHANS. Ueber die Veränderungen der Glomeruli bei der Nephritis nebst einigen Bemerkungen über die Entstehung der Fibrincylinder. Virchow's Archiv, Bd. 76, 1879. S. 85.

V. CORNIL. Nouvelles observations histologiques sur l'état des cellules du rein dans l'albuminurie due à la nephrite parenchymateuse et la nephrite interstitielle. Journal de l'anotomie et de la physiologie, année xv, 1879, p. 402.

occur during the progress of the malady. A good clinical history and a detailed record of the appearances observed during the autopsy appear to me, therefore, of the highest importance in every case selected for further histological researches.

In conclusion, let me express the hope that the suggestion made in the early part of this paper with regard to the training, at the expense of the general government, of one or more experts for the prosecution of this important inquiry may be found practicable. Our relation as a nation to this disease is quite unlike that in which we stand to most other maladies. It is constantly present at our very door, and constantly threatening to spread devastation among our people as it has recently done; but it is brought into no such close and threatening relations with those European nations who have been recently most successful in investigating the pathological histology of other diseases that they are likely soon to make it the subject of an exhaustive study. Nor have we much to expect, I suppose, from any inquiries the physcians of Cuba, Mexico, or other American countries south of us are likely soon to undertake. On the contrary, it seems in every way probable that if anything of value is to be done in this direction we must arrange to do it ourselves. That the means may be found for putting at least one zealous and competent inquirer into the field at an early day is to be earnestly hoped.

Very respectfully, your obedient servant,

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RICHARDSON, J. G. The paper of this gentleman, read at the meeting of the American Public Health Association, has not yet been published. I cite from an abstract in the Medical Record, vol. xiv, 1878, p. 435. See also the references to it in the paper of Dr. Schmidt, cited below.

SATTERTHWAITE, T. E. I cite from the report of the proceedings of the New York Pathological Society, stated meetings of September 24 and October 22, 1879. The Medical Record, vol. xvi, 1879, pp. 401 and 519.

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SCHMIDTLEIN, ADOLF. Das gelbe Fieber in Vera Cruz, 1865. Deutsches Archiv für Klinische Medicin, Bd. iv, 1868, S. 50.

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SUPPLEMENT No. 5,

National Board of Health Bulletin.

PROCEEDINGS OF CONFERENCE ON VITAL STATISTICS.

In accordance with a request made by the National Board of Health, and published in its Bulletin of February 21, 1880 (No. 35, page 265), the following-named gentlemen met with the Board in open conference, at Washington, D. C., May 6, 1880:

Dr. Azel Ames, of Wakefield, Mass.
D. A. H. Briggs, Health Physician, Buffalo, N. Y.
Dr. A. L. Carroll, Staten Island, N. Y.
Dr. R. A. Cleemann, Health Officer, Philadelphia, Pa.
Dr. C. W. Chancellor, Secretary State Board of Health, Baltimore, Md.
S. C. Cobb, esq., President of Board of Health, Pensacola, Fla.
Dr. C. W. Chamberlin, Secretary State Board of Health, Hartford, Conn.
Dr. E. Curtis, Medical Examiner, Equitable Life Insurance Company, New York.
Dr. S. H. Durgin, Board of Health, Boston, Mass.
Dr. Elisha Harris, New York City, N. Y.
Dr. E. M. Hunt, Secretary of State Board Health, Metuchen, N. J.
Dr. E. G. Janeway, Health Commissioner, New York, N. Y.
Dr. E. H. Janes, Secretary of American Public Health Association, New York, N. Y.
Dr. C. A. Lindsley, Health Officer, New Haven, Conn.
Dr. Theodore Mead, Register of Vital Statistics, Washington, D. C.
Dr. J. H Rauch, Secretary State Board of Health, Chicago, Ill.
Dr. E. M. Snow, Health Officer and Register, Providence, R I.
Dr. James A. Steuart, Commissioner of Health, Baltimore, Md.
Adolphe Schreiber, of New Orleans Cotton Exchange, New Orleans, La.
Dr. Pinckney Thompson, Secretary State Board of Health, Henderson, Ky.
Dr. Smith Townshend, Health Officer, Washington, D. C.
Dr. J. Howard Taylor, Philadelphia, Pa.
Dr. E. M. Wyckoff, Board of Health, Brooklyn, N. Y.
Dr. T. F Wood, Secretary State Board of Health, Wilmington, N. C.
Dr. C. B. White, Auxiliary Sanitary Association, New Orleans, La.

The Conference was called to order at 10.30 a. m., Dr. Cabell presiding.

Dr. Stephen Smith, chairman of the standing Committee of the Board on Vital Statistics, reported the following memorandum of order of business:

CONVENTION ON VITAL STATISTICS—ORDER OF BUSINESS.

I. The Standard Nomenclature.
(1.) American Medical Association.
(2.) Prof. Virchow's.
(3.) Dr. Farr's.
(4.) Royal College of Physicians; reasons for the last of these.
II. Basis of Complete Individual Records as Statistical Units; harmony and comparability of these records.
(1.) The tabular view (outlines).
(2.) The formal certificates:
Death.
Birth.
Marriage.
The attestation.
III. How to secure numerical completeness: the system.
(1.) In a city.
(2.) In a township and an incorporated village.
(3.) In a county and parish.
(4.) In the State.
(5.) In the organized corps of National service.
IV. The Periodical Summaries, Statistical Abstracts, Bulletins, and Reports.
(1.) For a week (in cities).
(2.) For a month (in cities and districts).
(3.) For a quarter (in cities, districts, and States).
(4.) For a year (in cities, districts, and States).
(5.) The National reports.
V. Methods of Revision and Perfecting of the Individual Records (the certificates).
(1). In cities, towns, counties, and States.
(2). Who shall be experts in such duty.

Dr. Smith also stated that a schedule of questions had been prepared and sent out to the State and Local Registrars, and to others interested in vital statistics, to which replies had been received and tabulated. The replies at length, as well as the different forms of registration in use, were upon the table and could now be seen by any gentleman desiring to examine them.

On motion, it was ordered that each speaker should be limited to ten minutes in his first remarks and to five minutes in his second.

A STANDARD NOMENCLATURE.

The President. We will now be glad to hear the views of the gentlemen present as to the expediency of adopting as the standard nomenclature that issued by the Royal College of Physicians of London.

Dr. Billings. No doubt all who have paid any attention to the subject of nomenclature and nosological classification are familiar with the fact that there are several different systems in use besides mere alphabetical lists. An attempt was made a few years ago by the American Medical Association to improve upon the nomenclature of the Royal College of Physicians, but the report of the committee was not adopted. This nomenclature is probably now undergoing the decennial revision provided for when it was published, and I think that the best thing which we can do to secure uniformity is to adopt provisionally this nomenclature, and appoint a committee to provide for such additions to the same as seem to be desirable after conference with the committee of the Royal College of Physicians now engaged in the revision. I have no doubt that this nomenclature as revised will be adopted by the Registrar-General of England, as well as by the colonial registration officers, and that if we can secure its adoption in this country it will become the system for all English-speaking nations. In attempting to secure uniformity in a matter of this kind, about which there have been so many opinions and plans, it cannot be expected that all the wishes of any one person will be exactly met. Each one will have to yield a little. This nomenclature is now used by perhaps a dozen health boards in this country, but very many use simply alphabetical lists without any attempt at classification.

Dr. Janeway. I am willing, for the sake of securing uniformity, to give up certain things that would perhaps seem desirable. I am in favor of adopting the nomenclature of the Royal College, as it is satisfactory in many respects, but I hope that the committee who have charge of its revision will remedy the defects and make additions to it. The same defects will no doubt be found in the other classifications, and additions would be found necessary to all. Certainly, until the revision is completed, for the sake of uniformity the nomenclature of the Royal College of Physicians should be adop ted since it will not prevent us from making any additions desired in the future. I would suggest the appointment of a committee to confer with the Royal College of Physicians on this subject.

Dr. Snow. I agree with what has already been said upon this subject. The great difficulty I have found is in classification. We want some way to get the best name for every disease, and also to know where to classify certain diseases. I have given considerable attention to the subject of classification, but have never been satisfied with any system I have seen. I hope to use a classification that will be at once scientific and practical. If this nomenclature be adopted, does it include the arrangement or classification for tabular work?

Dr. Billings. I have been speaking of a nomenclature only and not of a nosological arrangement, but I would adopt the classification of this nomenclature also temporarily, since it is quite as good as an alphabetical arrangement, and would make it convenient to readily compare our work with that of the Registrar-General and of the Provinces of Great Britain.

Dr. Snow. I would give the list of diseases a strictly alphabetical arrangement, and keep certain classes of diseases separate.

Dr. Cleemann. I think the alphabetical list better, because it involves no theory, but we must also have a classification. The method adopted in Philadelphia is to print an annual alphabetical list. The same would be accomplished by an index. Then in working up the report adopt Farr's classification, so as to compare it with that of England. It is better for future reference to have an alphabetical list, because our ideas may change in future years.

Dr. Carroll. It seems to me that pathology is scarcely enough advanced as yet to have a really scientific classification in our returns. As I understand it, a nomenclature is only for our convenience in classifying diseases, and if we could be sure that all the profession were familiar with the nomenclature of the Royal College of Physicians, it would be, for the present at all events, the most desirable one to adopt, with the understanding that all systems must, with our advancing knowledge, be subject to revision.

Dr. Hunt. If this nomenclature should be adopted it should be provisionally. It seems that from an American point of view and from the fact that we have to meet relations of disease quite different from Europeans, we had better at once enter upon the idea that there must be an examination of the Farr nomenclature. We have to keep clear the distinction between nomenclature and classification. A great many things enter into nomenclature that are important to be left out of vital statistics. There are a great many classifications that need to be reviewed. I hope one of the first duties of the body will

be to appoint a committee to get at this work. We have been following the Farr classification too much. We need a thorough review of that classification. I feel that this adoption should be so far provisional that this committee should be at work not with the idea that there are some changes desirable, but that one of the first things needed to make a thorough work is to have a complete study of this whole subject of nomenclature and classification as related thereto.

Dr. BAILHACHE. The Marine Hospital Service has used this nomenclature and classification for several years and found it very satisfactory. There were, of course, some changes necessary to be made in it which could be made by a committee as suggested, but taken as a whole, it had certainly been found by the Marine Hospital Service to be the most satisfactory nomenclature and classification, and they heartily indorse it.

Dr. BILLINGS offered the following resolutions:

First. That the nomenclature published by the Royal College of Physicians of London, be provisionally adopted with the understanding that in so far as names of diseases or pathological conditions are not contained therein each one shall be at liberty to use such name as he deems best.

Second. That a committee of five be appointed by the Chair whose duty it shall be to indicate the most urgently needed additions to said nomenclature at the present time, and that this committee shall be instructed to confer with the committee of the Royal College of Physicians in charge of the revision of said nomenclature with reference to obtaining an uniform system both for Great Britain and her colonies, and in this country.

Dr. HARRIS. In seconding the motion of Dr. Billings I wish to call the attention of the gentlemen present to the original intention of the distinguished medical authorities in this nomenclature as we have it after their nearly twelve years' labor. Dr. Farr entered upon the service with alacrity, and has illustrated his own good will toward the nomenclature as published. He still retains, as all the local authorities of England do, the practice of using certain phraseology that has become almost a part of their vernacular in medical conversation, such as the term "Zymotic" diseases which corresponds with Division A, Class 1, of the published nomenclature. In a note in the edition of 1869, we find that the design was to secure a standard nomenclature which should be accepted by all nations. Before we dismiss this subject we may find that in recommending the adoption of this system for a standard nomenclature we need to agree upon certain things that are not provided for by this resolution, or by the adoption of a mere nomenclature in any sense. There are certain matters pertaining to the mode of rendering reports from any of our large cities, which I think make it quite convenient, if not necessary, that we still consent to use some of the familiar expressions that pertain to the nomenclature which is so common among us. Without taking any exception to the resolution, I call attention to the fact that the nomenclature as it stands would merely be a guide to uniformity in the use of names, causes of death, and description of diseases. In determining upon a separate mode of expressing the general facts relating to prevalent diseases, totality of disease, causes of death and their groups, another question will need to be raised. The nomenclature is all-important as a guide to the correct statement of the causes of the death which shall be readily understood and recognized by us whatever report we may be reading. I find that in the cities of India they follow the nomenclature of the Royal College of Physicians, without inconvenience, by dropping the word "Zymotic," as expressing a class of general diseases, and substituting Division A, which covers the diseases by name, with here and there an insertion of the zymotic group.

As regards some special types of our diseases the nomenclature would be at this moment insufficient to carry all the definitions which are necessary. It is not as large a nomenclature by some four hundred names, as the nomenclature which was recommended by the committee of the American Medical Association in 1872–'73; while, on the other hand, the nomenclature proposed by Professor Virchow, in 1873, in the Statistical Congress at Berlin, gives a very brief classification. The statistics of Berlin for ten years have been made up in accordance with this nomenclature in an experimental way, which shows that this has been found a very available nomenclature for German countries. While we may not be able to secure, through European countries, uniformity with this nomenclature, it is fortunate that the nomenclature of the Royal College of Physicians is becoming a popular classification, as far as I have been able to read the comments of different statisticians.

The question was then put on the resolution of Dr. Billings, and it was unanimously adopted.

Dr. BILLINGS. I will now move that the committee which has just been ordered to be appointed to take charge of this nomenclature and correspondence be instructed to bring the matter to the attention of the American Medical Association at its meeting in June, and to communicate with the different registrars, State and municipal, throughout the country upon the subject, requesting them to join in the adoption of this nomenclature in accordance with the resolutions passed to-day.

Dr. RAUCH. In seconding the above motion I may say that I am deeply interested in this subject, and want of time alone has prevented me from preparing some schedules of nomenclature. If this classification is satisfactory it could be adopted in the State of Illinois without any difficulty, and it is much easier to start right than to make changes afterward. A new State Board of Health has been created in Iowa, and it is very desirable that prompt action in this matter should be taken in order that these new boards may take advantage, at the start, of the action of the convention. The returns of the county clerks to the State Board of Illinois will soon be sent in, and if they had the proper forms furnished them they would soon become accustomed to the way of reporting on these new forms. I have been hesitating as to the course in Illinois, and waiting for the adoption of some nomenclature and think that action should not be postponed.

Dr. HUNT. The nomenclature should be at once adopted. I am receiving letters constantly from cities calling for prompt action in this matter. The delay forms the only objection I have to corresponding with the college, and would ask if it were not better to prepare something at once without waiting a year or two. Dr. Farr himself appreciated the fact that we needed an American nomenclature and classification, and while it would perhaps be wise to adopt this nomenclature provisionally it would have to be a very provisional adoption.

Dr. THOMPSON. To what body will this committee charged with correspondence with the Royal College of Physicians report? The sooner the committee reports or adopts some measure, some plan of nomenclature, the better, as time is now of much importance. Kentucky has no vital-statistic law unless it has been passed in the last two or three days.

Shall we (Kentucky) wait for this committee to report or shall we go ahead? I would like to know when this committee would report, and would move that the committee be instructed to prepare a plan, &c., and report to the various State and municipal boards and recommend its adoption.

Dr. JANEWAY. If we hurry through an American form without waiting to see what the English may do, we shall have to go through with it a second and third time and meet to make the changes necessary. I favor the provisional adoption of this nomenclature until the change is made. It is unnecessary that each physician should have this nomenclature; all that is necessary is that the Registrars should be able to make up their record from the physician's report.

Dr. RAUCH. I do not think it is necessary to wait until this is perfected; we can adopt the general plan now, and perfect the details hereafter.

Dr. BILLINGS. The nomenclature has been adopted provisionally, and is to be used with the understanding that the committee should go on and perfect it. If any one has a disease to report which is not in this nomenclature let him name it as he pleases until it has been provided for. We can best treat this subject as we do the revision of our pharmacopœa.

Dr. RAUCH. It is my intention to have this nomenclature adopted in Illinois. There is in Illinois a greater diversity of diseases than in any other State of the Union, and a greater diversity of local names. I am anxious to have something practical done as soon as possible.

Dr. HARRIS. Dr. Janeway has presented the true solution of any difficulty in regard to registration. The gentlemen from Illinois and Kentucky will find it entirely practicable in the central office of registration, if not in the local office, to correctly translate whatever is returned without worrying the physicians at large with the new doctrine. It is entirely practicable to take any correct statement of the cause of death and correctly translate it into the best nomenclature. This is so true that there has been no difficulty in the last three or four annual reports on the part of the Registrar-General of England to place correctly the diseases that had been in antecedent pages otherwise classified and to give the same number of deaths in the new classification, and it is quite interesting to look over those annual statements and see the results of the gradual introduction of this new arrangement.

Dr. BILLINGS's motion was then put to vote and was unanimously adopted.

Dr. JANEWAY. I offer the following:

"*Resolved*, That for purposes of classification the general diseases be grouped together as proposed in the nomenclature just adopted, and that local diseases be arranged alphabetically by systems and organs."

Dr. RAUCH. It seems to me that this would simply complicate matters.

The PRESIDENT. The nomenclature only has been adopted. This is a distinct motion for the adoption of a classification.

Dr. CLEEMAN. I should prefer an alphabetical arrangement pure and simple. We can afterward make a more perfect classification, and perhaps it would be better not to tamper at all with the alphabetical list.

Dr. AMES. I have found it almost impossible to translate into proper terms some of the names used by my correspondents or to put them under any head. The Committee on Nomenclature should take into consideration also the question of classification.

Dr. SNOW. I concur in this view.

The question was put on the passage of Dr. Janeway's resolution, and it was carried.

II.—BASIS OF INDIVIDUAL RECORDS—CERTIFICATES.

Dr. BILLINGS. I wish to call attention to the schedules of the various items of information which are called for in certificates of death and of

birth. [See Appendix A.] It will be seen that very few items in these different certificates are called for by all the cities. I move that a second committee of three be appointed by the President which shall be instructed to report back to this convention this afternoon a form showing the minimum information required on a certificate of death for purposes of burial. This is the first information wanted by those who are called upon to establish a system of regulations.

Dr. CARROLL. I second the motion. I have been much perplexed by the difference in the forms, some of them calling for information that may be entirely unattainable. The form used in New York contains queries which it is sometimes impossible to answer, such as the birth-place of the parents of the deceased. A case in point was where a gentleman belonging to one of the first families in New York died, and in filling out the certificate it was found impossible to ascertain from any of the gentleman's family whether his mother had been born in New York or Pennsylvania; and it was nearly twenty-four hours before the undertaker could get a permit for burial. Another question is, from whom shall these certificates be obtained? Many of the counties of New York are without Boards of Health, and no certificates of burial are required. It seems to me that the duty of reporting deaths should be thrown upon the laity instead of upon the profession.

Dr. JANEWAY. When it is impossible to give the native State of the parents of the deceased the name of the country would answer.

Dr. BRIGGS. The first duty that I shall be called upon to perform upon my return to Buffalo will be to prepare a set of blanks for burial permits. I think that the question as to who should furnish the certificates ought to be settled definitely, as being one of great importance. The city of Buffalo is unfortunate in that it was obliged to have its cemeteries just on the outskirts of the city.

The motion of Dr. Billings was then put and carried.

The President appointed on the committee Drs. Snow, Cleeman, and Carroll.

III.—HOW TO SECURE NUMERICAL COMPLETENESS.

Dr. BILLINGS. I should be glad to have the opinions of the gentlemen present upon the following points:

A. Should physicians be required to certify to anything more than the cause of death?

B. Is it desirable that we should state whether the cause has been ascertained by an autopsy? We have, and must have, what amounts to two nomenclatures; the first a clinical one, expressing the aggregate of symptoms, as for instance, "locomotor ataxy;" the second that used by the pathological anatomist, who describes the results found after death, for instance, "cerebro spinal sclerosis."

C. How far should the physician be allowed to say that he does not know what the cause of death is without necessitating a coroner's inquest? It seems to me that some way should be devised by which the physician can in professional phrase let the registration office know that he is ignorant of the cause of the death without letting the family know it. The registration of deaths has three purposes:

First. Information for sanitary ends; to serve as an immediate warning.

Second. For statistical purposes; to enable the physician to study the results of diseases, according to sex, age, locality, occupation, color, race, &c.

Third. For judical records, including such information as the names of the parents and their birth-place, and the demand for this class of information in connection with titles to property, &c., is increasing with the large emigration to this country.

Dr. CLEEMANN. We should avoid attempting too much. We should not attempt to teach pathology by a system of registration; it is more to give us information as to prevalence of certain diseases than anything else. I favor the simpler form of registration—of restricting the registration merely to the name of the disease. The physician is the proper person to give the certificate, as he is generally better informed than any one else as to the cause of the death. The method employed in Philadelphia, while somewhat imperfect, gives a registration of all deaths, the undertaker and cemetery superintendents acting as checks upon the physicians. Strictly speaking we have no burial permits, but the physician's certificate is indorsed by the undertaker who returns the certificate to the office of the registrar. No undertaker will dare to bury a body unless he has a physician's certificate, as he is subject to a fine. These checks enable us to cover the whole ground and get tolerably complete returns, though perhaps in some other cities the condition of the poor is not so good—they may not always be buried in the cemetery.

Dr. HARRIS. The difficulty of obtaining a complete numerical count of the deaths in any State, even the best regulated, is so great that undoubtedly it is the true policy to discover the minimum of requirement. We must know what is the minimum of the obligation which is due to the family, the community, the public health, and all that may be concerned in the event of the death. The German certificate is generally a very brief one; the registration may not be the most perfect, but they have discussed this particular duty of minimum obligatory requirement upon the physician. Practically the physician furnishes the whole certificate in most of our States where there is registration, and in nearly every city, including what is necessary for the record of lineage of the deceased. We have given us a perfect example by Dr. Snow, with a remarkable success, and he has prescribed the form that most of us found convenient to adopt for the certificate of death. The Royal College of Physicians has stated the principle upon which we should proceed:

"This general, or common, or standard nomenclature need not be imposed upon every nation and people as its proper nomenclature. It could not. It would be unintelligible by the people at large, and embarrassing to those by whom the necessary returns must be made. But the nomenclature proper or peculiar to each country, and which may be called its national nomenclature, should be readily convertible into the standard nomenclature.

"Among the great ends of such a uniform nomenclature must be reckoned that of fixing definitely for all places the things about which medical observation is exercised, and of forming a steady basis upon which medical experience may be safely built. Another main use of the statistical registration of diseases on a wide scale is that it must tend to throw light upon the causes of disease, many of which causes when duly recognized may be capable of prevention, removal, or diminution.

"A good classification aids and simplifies the registration of diseases, helps toward a more easy comparison and knowledge of them and toward the storing of experience respecting them, and facilitates the discovery of general principles from the collected, grouped, and compared phenomena."

Dr. STEPHEN SMITH. The particular question before the conference is, how can complete returns, embracing every marriage, birth, and death in each city, township, or parish of the State be obtained? The laws and ordinances of municipalities and States under which these returns are made are various, and it will be only by a comparison of views of gentlemen representing different sections that any progress can be made in this conference in determining a best plan or method. Would it not, therefore, be much better to refer this subject also to a committee consisting of one member from each State represented, and an additional one from the large cities, as New York, Boston, Philadelphia, New Orleans, and Chicago? This committee would compare the different methods now pursued, and might harmonize them. I move, therefore, that this subject be referred to a committee to be appointed by the chair.

Dr. JANEWAY. I would propose as an amendment that the subject be divided, and that two committees be appointed, one to report some uniform method for obtaining returns from the large cities, the other to get returns from smaller towns and country districts.

Dr. STEPHEN SMITH. I will accept the amendment.

Dr. CARROLL. I think it important to keep entirely distinct the question of registration in the larger cities and that in the State at large. Numerical completeness may be obtained in a very simple way. If we could insure in every part of the country that no interment should be permitted without a record of the dead that would at once answer the purpose of securing numerical completeness. In most of the counties of New York there is absolutely no means of obtaining that as yet. The question in the larger cities where boards of health exist of course would be a simpler one to consider. The means of obtain-that nominal completeness throughout the rural districts would, I presume, have to differ in almost every State. Laws in one State would be unconstitutional in another. In New York, the only way in which we could do anything was to attempt to get an act passed empowering county supervisors to record all births and deaths.

Dr. THOMPSON. We have had but little experience in Kentucky, except in a few localities, in gathering these statistics. I am very confident that even the large cities of the West, including Cincinnati, Saint Louis, Louisville, and Chicago, do not obtain perfect returns, much less the States at large. It is impossible to give anything approximating a correct death list except through the physicians. And yet some physicians think you are inquiring into their private affairs when you require that they state the causes of death of their patients. The parents and guardians also think the causes of death of friends concern only themselves. In Kentucky we are endeavoring to compel the physicians to make the certificate under oath. It would take years to educate the public to make these returns, but we can educate the physicians much sooner, and I think that the whole duty must be put upon them. It is true that it is for the benefit of the people, but it is also for the information of the profession, and hence, in my opinion, no dead body should be buried without the certificate of the physician.

It is perfectly clear to me that in the rural districts it will be impossible ever to gain anything that will be satisfactory except through the profession.

Dr. HUNT. I will remark on the point that Dr. Billings has raised, viz: How to secure numerical completeness. It seems to me we at once come to a distinction between births, marriages, and deaths, and I have only to remark in regard to deaths now, I can see no reason why the medical profession should be required to be entirely responsible in this matter. But if a plan could be adopted by which undertakers are licensed and then hold them responsible for getting all the data from the family except the cause of death, I think it would be the best plan. But I am hopeless of getting such a law in each State. In New Jersey we first started to get a general law by which every physician is called upon to report deaths. We have considerable difficulty with regard to births; we have had none with regard to deaths. I should be surprised to find that twenty or thirty persons were buried in New Jersey last year without a certificate of death duly returned

to us, unless surreptitiously buried. The plan we adopted was first to have a general law, to have for each an assessor, and in each city a city clerk, whose duty it is to look after this matter and receive pay therefor. They receive ten cents for each return. We must create opinion in the profession favorable to the performance of these duties, and this we are doing in our State.

Dr. BRIGGS. In Buffalo I think we have an ordinance of the common council, imposing a fine of $10, $15, or $20, if within twenty-four hours a certificate of the cause of death is not filed with the city clerk. But the facts are, I presume, that not more than two-thirds are properly filed. It is the custom there for the undertakers to make out certificates and putting down the cause of death. I have reason to believe that frequently the true cause is not filled in. Sometimes they put these certificates into a pigeon-hole, after they are made out, and leave them there, simply because they were not compelled by law to have a permit from the city clerk to bury. It has occurred to me that the best method that we could have in the city of Buffalo would be to compel the family to fill out the blank and take it to a physician for his indorsement on it of the cause of death. Our Board of Health is an *ex officio* board. The law is not enforced in the least, and we have very imperfect returns. The clergy do not report the marriages, and the doctors, in very many cases, do not report the births. How to make them do it is what I wish to find out.

Dr. SNOW. In the city of Providence we have a system which gives nearly complete returns of deaths. The first point to be aimed at is to have the smallest possible number of persons responsible for the returns. We exclude householders and physicians, and place the responsibility on the undertakers. We require, first, that the undertakers shall be licensed; next we pay them a fee for returning a death, a very small fee, five cents in the city and ten cents in the country. We require them to obtain three certificates, which are upon a single blank. The first contains the information in regard to the person who has died, age, sex, &c., under fourteen questions. That certificate is to be signed by some member of the family, usually by some responsible person from whom the undertaker is required to get the information. The next is the physician's certificate, containing simply date and cause of death. That is all we require the physician to sign, and he has no responsibility except signing that. We require the undertaker to go to him, and when it is presented he is to sign it. The last is the certificate of the undertaker. It makes a convenient form for all purposes and contains all the information necessary—not all we would like to have on many points, but all that seems to us we can conveniently demand. The result of this has been that for a number of years we have had hardly any deaths not returned. It requires, however, constant watchfulness. We have a voluntary system by which the police of the city report every day funerals and deaths. It is not by ordinance, but by the consent of the chief of police. They report the number of funerals they see or deaths they hear of every day, giving the name and location, and this is compared with the other returns. I may occasionally find one death that has not been returned, but I do not remember that I have actually found one. Sometimes they are a day late in returning. Burial permits are required. No one can be buried or removed from the city or placed in a tomb until the death has been returned and a burial permit granted. I do not know that I could suggest in a city any better system than that I have mentioned. It is important that the responsibility should be confined to a few persons, and that physicians be not required to have any responsibility. They are not, in the first place, in a situation to get the particulars of the family, it is not their business, and it ought not to be asked of them. But it should be asked of them to certify to the cause of death. The following is the form used in Providence:

RETURN OF A DEATH.—CITY OF PROVIDENCE.

1. Date of death? 187
2. Name in full? ....
3. Age? ....Years..........Months..........Days
4. Place of { Street and number? ....
5. death. { Ward? ....
6. Sex? ....
7. Color? ....
8. Condition? ....
9. Occupation?* ....
10. Where born? ....
11. Father's name? ....
12. Mother's name? ....
13. Parents' birthplace? ......Fa..........Mo..........
14. Where to be buried? ....

...., *Informant.*

N. B.—At Nos. 4 and 5, give the *place where* the person died. At No. 8, state whether married or single, widow or widower. *At No. 9, if the deceased was a married or widowed female, give the name of her husband. At No. 10, give the *town and State*, if in this country. At No. 13, state *the country* in which each parent was born.

PHYSICIAN'S CERTIFICATE.

Date of death? 187
Name? ....
Disease or cause of death? { 1. First..
{ 2. Second..
....
Duration of disease? First ....Sec. ....

...., *Physician.*

I certify that the above is a true return, to the best of my belief.

...., *Undertaker.*

Dr. LINDSLEY. I have very little acquaintance with the methods of collecting statistics, except in Connecticut, my own State. It is now more than twenty years since the law was put into effect, and it has some modification since that time. But we started with the idea that it was the duty of the physicians to present the certificates of births and deaths, and I believe that is the general sentiment of those interested in this question in the State. But the legislature recognized the fact that if they required this duty of the physician some recompense should be made for it, and 25 cents was allowed for each certificate returned to the Registrar of the towns in which the birth or death occurred. The requirement has been modified in regard to the time in which the return should be made. A burial permit is required, the permit to be based upon the certificate returned by the physician, and the physician is liable to a fine in case he refuses to give such certificate. In no case that I have any knowledge of has there been occasion for such a fine. I believe that it is the most successful way, because the physician is intelligent, and would naturally take far more interest in the matter than undertakers, and I question very much whether the system of collecting certificates by undertakers would be very successful if it were not for the constant supervision which Dr. Snow says is practiced in Providence. We found difficulty in Connecticut in this way in various parts of the State. The law allowed every town to elect a Registrar, but in failure of such election the town clerk was to be the Registrar. Wherever he was Registrar very little interest was taken in the matter of these certificates, and frequently he would make collections of them but once a year. But where a Registrar was elected he took a personal interest in it, and the collections and records were far more accurate than elsewhere. At the present time we have a law by which in all the cities of the State a permit for burial is required. That has been since the organization of the State Board of Health two years ago. I believe that it has operated so far very well, and the records numerically are almost perfect. I know that it is so in New Haven. I do not know of a single instance where a body has been buried without the necessary permit. I believe that the physicians are the proper parties to look after these matters, and that we can educate the profession to the practice of giving them. Where they are required to give them, they might as well be required to give the whole certificate as a part of it, for they are in a position to collect the facts. They should be paid for it a moderate sum sufficient for the collection.

Dr. JANEWAY. In New York City the physicians give the certificates altogether. We do not fail to get a single certificate. Nobody can be taken out of the city without a burial permit. I believe if we were to-day without the system of requiring burial permits, we would fail to get a certain number of deaths, because we could not get the undertakers to make complete returns. The law requires that the physician shall make the return, but practically the undertaker always takes the certificate to the Registrar. The physician would be liable if it did not get there. The physicians are registered; the undertakers are known.

Dr. CLEEMANN. We have undertaker's certificate and also physician's certificate on the same blank. I think in Philadelphia the undertakers are registered, and an inspector is detailed for the purpose of going around among them at certain times to see that they are attending to their duties in returning these certificates. The certificate from the cemetery is entirely a different thing. It is not on the same blank. If it is found that those certificates do not coincide the matter would be inquired into, and if anything is wrong, a fine of $25 will be imposed all around. One has been enforced within a month. The certificate is returned by the undertaker.

Dr. THOMPSON. In Kentucky there are no registrars, but we have city clerks, and it is a finable offense for the undertakers to bury any one without authority from the city clerk to dig the grave. The city clerk cannot give that authority until he receives a certificate of the physician. The family have to get that from the doctor. It is generally made the duty of the head of the family to carry that certificate to the physician wherever his place of business is, and I understand it works well.

Dr. STEUART. That is like the system of Baltimore. We have a penalty for burying without a permit from the Health Department. The penalty rests upon three persons, the cemetery-keeper, the undertaker, and the physician.

Dr. RAUCH. There is no trouble in Illinois. But the undertakers are not the parties who are compelled to make returns. The medical men are the parties responsible. The certificates are as a general rule brought to the office of registration by undertakers, who are punishable by fine, as are cemetery-keepers and physicians, for neglect of duty. With regard to the person who should make these returns, I would ask this question: Ought not this responsibility to be divided? In Illinois the duty rests entirely on the medical man. Recently the question of fee has been raised. Before that was raised there was no trouble at all. I think it is the duty of the medical men to make these re-

turns. They can do it better than any one else. It does not require a great deal of time and trouble to obtain what is required. I know until the question of fee was raised in a certain medical society in Chicago, practically there was no trouble in the State of Illinois. Since then some think they ought to be paid for it.

There is another point to be borne in mind. It is sometimes with the utmost difficulty that registration laws can be passed. Medical men generally are the parties who are interested in sanitary reform, and if they would ask compensation it would defeat the very object, for it is exceedingly difficult to make anything of this kind uniform. I think, however, that it is necessary to hold the medical men responsible, and also the head of the family. I do not believe in allowing undertakers, as a rule, to have control of this matter or to depend on them, but you can use them as agents in carrying out the law. Outside of our large cities in Illinois no burial permits are required; we must depend upon the medical profession. The registration I know is not complete. The great difficulty in regard to registration in many places is simply owing to the want of interest on the part of those who should see that the law is enforced. It requires constant vigilance and care. Unless you have that, no matter what the law is, it will amount to nothing. It is almost impossible to have the same laws passed for the entire country, because the conditions obtaining are so different in different places.

Dr. SNOW. It seems to me to be the greatest injustice to make physicians responsible for these returns. The physician has nothing to do with the burial or removal of the body, has no means of knowing when it is done or how it is done. It can be done without his knowledge entirely. It seems to me it would be unjust to make him responsible for the return, and it would be impossible to enforce any such law. The physicians would not do it, and I would not ask them to. But perhaps the physicians of other States are different from those of Rhode Island. In regard to the number of persons responsible, if we require physicians to be responsible we have got to look to one hundred and fifty physicians, while we have only ten or twelve undertakers. I am confident we could not enforce the law requiring physicians to be responsible for the furnishing the certificate, although we can get them to sign it.

Dr. THOMPSON. We have no difficulty in Kentucky in getting all the information in regard to the certificate. The penalty imposed on the sexton of the cemetery takes the difficulty entirely off our hands. They are not allowed to bury anybody without a permit from the Health Department, and the Health Department will not grant certificates unless they are signed according to the ordinance. Therefore the body cannot be buried until they get the certificate from the physician, filled out by the family, and he (the physician) puts in the cause of death. Then it is given to the undertaker, brought to the Health Department, and the permit is issued for the burial.

Dr. SNOW. Suppose the body is to be carried outside the district?

Dr. THOMPSON. Then the body is not allowed to be taken out by any undertaker without a permit.

Dr. AMES. The bulk of the discussion seems to be upon the registration of cities, as might naturally be supposed. But there is a broad field in the country districts. A year ago I paid considerable attention to it in connection with a bill before the Massachusetts legislature looking to this matter of collecting vital statistics. But it is extremely difficult to pass such a bill through a legislature which is always largely composed of country members when it does not make a provision for their peculiar condition. The trouble with the country districts is that they are sparsely settled, and a physician is called over a large territory, and unless he attends to the certificate at the moment of the death he may not be able to attend to it for some time afterward. He may be forty miles away twenty-four hours after death. And the question was put to the legislature of Massachusetts whether the people of the country should be refused permission to bury their dead because within the twenty-four hours required by law we cannot find our physician. I wished very much at that moment when those points were brought up that there might be some provision made in such cases where some authorized officer could give the permit, to be attested by the physician on his return. Of course the matter is entirely different in the large cities. But in the outlying territory with which we have to deal, with an aggregate population as large as a city, you must have different laws from those which apply to the cities, or else you involve hardships which make it hard to pass a law. And I believe many States are without a registration law because they cannot pass by their legislatures a bill which does not make special provision for their peculiar interests, the interests of the country districts. If there could be some one to visé the return of the householder who makes the primary return, if some officer of the town could visé it—and I believe something of that kind might be done—registration laws might be passed so as to secure everywhere completeness of returns where now no law could be passed. And I commend that feature of it to the attention of the committee, as one which must be everywhere met, and one which ought to be met intelligently, and at the same time registration be effected.

Dr. WHITE. These duties in New Orleans are managed as follows: The Board of Health passed an ordinance stating that nobody shall be buried in any part of the city nor removed from the city without a permit from that office. That permit is based on a certificate of the physician. It is considered the business of the family to furnish the certificate, but the doctor signs it. There is no difficulty of the working of that matter in New Orleans. No dead body can be removed from the city without a permit from the Board of Health, and a fine can be levied on the railroads for carrying out bodies without permits. The charge for the burial permit is, I think, fifty cents. The money for these permits goes into the treasury of the Board of Health.

Dr. WYCKOFF. While our ordinances are essentially the same as those of New York City, it is perhaps necessary to say that we have found that the undertakers cannot be relied upon. We are strongly of the opinion that the physician is the person who should be required to furnish the entire certificate of death. We are of the opinion that two handwritings are objectionable on the same document, and ordinarily a certificate of death is returned if there appears to be a correction or an addition made by the undertaker. The undertaker's handwriting is on the back of the certificate of death, stating the place of interment, date of interment, his name, and place of business. Our experience has been that the undertakers are as a class antagonistic to the Board of Health. Or it may be that the Board of Health has occasioned so much inconvenience to the undertakers that they have assumed the defensive or offensive, according to the point of view we look at it. In regard to the question raised by Dr. Billings, I would say that one person should be required to give the facts required with the exception of the interment, the facts in regard to which are often unknown at the time the certificate is in the hands of the physician, the family not having determined that.

Dr. DURGIN. There seems to be quite a uniformity in the laws and customs in the New England States. In Massachusetts the law recognizes several parties as accountable for these returns. First, the undertaker, who is principally responsible; then the physician. The undertaker is required to collect and return certain facts—the majority of the facts called for by the law. Then the physician is required, if called upon within fifteen days from the date of the death, to give the duration of illness and the cause of death. He must do this under a penalty. The undertaker, therefore, is the proper party to collect these facts. The physician should not be required to collect so many facts entirely outside of his real professional duties. Again, the undertaker in Massachusetts is not allowed to bury any body, nor to remove it from any city or town, until he has first obtained from the registrar in cities or the town clerk in towns a certificate to the effect that a return has been made of the death by the physician, the undertaker, or other person having charge of the funeral or burial; and he must obtain from the clerk of the town or the registrar of the city not only this certificate of facts but a permit to bury the body, and if he violates this law he is subject to a penalty of not less than $25. No dead body should be buried or removed until these records have been made and the permit to so remove or bury has been obtained from the proper officer. If these details are neglected until the body has been removed or buried, great difficulty will be experienced.

The towns of Massachusetts are very well provided for; the law authorizes the board in every town, however small, to sign the certificate of the cause of death. If no board of health has been appointed, then the selectmen are the board of health. In a city, the board of aldermen constitute the local board of health. In 1878 the law was amended and this was added: "Upon application, the chairman of the local board of health, or any physician employed by any city or town for such purpose, shall sign certificate of the cause of death, to the best of his belief, if there has been no physician in attendance. He shall also sign such certificate upon application where the certificate of the attending physician could not be early enough obtained." By the operation of this law even the smallest town in a State is well provided for. When the law says, "no body shall be removed from that town or city until these facts have been obtained and recorded," the people will very soon accommodate themselves to the condition.

Dr. AMES. The bill to which I alluded before was pressed for the following reasons: In 340 towns, 182 town clerks confessed that they were in the habit of giving undertakers burial certificates whenever they called for them and getting physicians' certificates whenever they could. Although, as Dr. Durgin says, the Boards of Health could be called upon by the law of 1878 to sign whenever, from any circumstance, the physician has gone away or there has been none, yet the practical result was that death by violence, arsenic, abortions, &c., might occur and the statement be made that no physician was in attendance, and the officer of the town acting as the board of health would sign the certificate, and the burial permit issued, and the evidences of the rascality be removed beyond cognizance almost immediately, and therefore could never be known. It became apparent that to avoid negligence of the town clerks and physicians in this matter, and to avoid the danger of malpractice and concealment of deaths by violence, some more convenient method had to be passed. And yet that latter provision is one which I could not help feeling ought to exist in regard to the country towns where the physician must often be absent from town after the death of his patient, or may be away at the time of his death. There ought, undoubtedly, to be some provision where such a person could be buried legally.

Dr. DURGIN. It is a violation of the law for any town clerk to give a permit for the removal of a body, or the burial of the same, until these facts have been returned to him and recorded. Any person vio-

lating the provisions of this section shall be punished by a fine not exceeding $25. If there is the slightest suspicion of violence then we have a provision in every county of the State whereby a person, called the "medical examiner," can be summoned, and he has full authority in the premises to make an autopsy, and give the death certificate, but in all other cases where there is no suspicion of violence and still no physician in attendance, or for any reason, the certificate of attending physician cannot be obtained, then the local authority has the right to summon a physician, or the chairman of the Board of Health.

Dr. HUNT. I wish to call attention to the law of New Jersey on this subject: "In case of any person dying within this State, it shall be the duty of the physician who may have attended him during his last illness, to furnish the undertaker, or any member of the family applying therefor, a certificate of death of said person, which certificate shall show the name, age, sex, color, nativity, occupation, last place of residence, place of death, and cause of death, according to the best of his knowledge, and said certificate shall constitute all the necessary burial permit in any township of the State outside of city or incorporated or county health board limits, and the undertaker shall, within five days after said burial, send the same by mail, or otherwise, to the assessor of the township in which the deceased died, under a penalty of $50, as herein provided." This compels the undertaker to see to the business. The physicians is watching him to see whether his duty is attended to, and he knows whether he buries without a permit; the man who gets 10 cents, the assessor, is watching him, and some of them are very watchful indeed; the Registrar is watching, and we are constantly watching. It requires great care on the part of the Registrar, but nevertheless it is done. Now we had to encounter the same difficulty mentioned by Dr. Ames in the country districts; so we had a provision incorporated in the law to the effect that in burying any person who died in any township in the State outside of city limits, or county health board limits, the certificate of any regularly graduated physician of the township wherein the person died shall be held by the sexton or undertaker as the only necessary burial permit, and the undertaker shall, within five days after said burial send the same, by mail or otherwise, to the assessor of the township in which the deceased died, under a penalty of $50. No complaint has been made in regard to that requirement. In regard to births, I have always had this idea, that, inasmuch as another person can fill out the particulars as well as the physician, it is at least a complimentary work on his part to do so. We require in our State that he shall return the day of the month and year of birth, the precise place of residence, the names of both parents, and the maiden name of the mother, the birth-place, residence, and occupation of the parents, the sex and color of the child, and its name, if it be named; also the name of the atttending physician; and if the assessor finds any return of birth not made he may fill out the proper certificate and mark it "special return." If at the time the State Board of Education makes an enrollment of every child between the ages of 5 and 8, an enrollment of all children under one year of age could be made, we should have a more correct list of births in some of the districts than could otherwise be effected.

Dr. RAUCH. In regard to compensation I have but one remark to make on certificates or returns. I think it would be imprudent and impolitic for an organization like this to recommend that compensation be given. That will do in certain parts of the country, but it will not do in all. The question was brought up before the Medical Society of Illinois, and by an almost unanimous vote it was defeated. But the very agitation of this question at this time has done a great deal of harm. I therefore think it would be imprudent or impolitic to recommend it universally or in all localities. The medical men of the country generally are engaged in securing legislation with regard to sanitary matters, and if the opponents conceive the idea that they are doing it for the purpose of making money you will find that the legislation of the country will be set far back in those States where it is not obtained at this time.

Dr. BILLINGS. From what we have heard there are almost as many different ways of getting these certificates and returns as there are places, and yet they are all stated to be perfectly satisfactory, and in every place where a burial permit is required the returns are considered fairly complete. But I think it will be found on consideration that in many of the places that is due to the gentlemen who manage the work. The duty of the physician as to giving these death certificates may be considered from two points of view: First, does the legal obligation rest upon him to make out and present such return irrespective of compensation of any kind? I am of the opinion that it does not, and that any physician who chooses to push the question to the extreme in the courts will always conquer, for the reason that you cannot by law require a man to do a thing without giving him some sufficient inducement, some *quid pro quo*. It is not the physician who is to be benefited by this certificate; it is the community or it is the individual householder. You can undoubtedly by law compel the householder to furnish any information with regard to a dead body on his premises that you choose. The householder must go to the physician to obtain a certificate as to the cause of death, and he may be compelled to pay the physician for that certificate. It is by no means clear that it is the duty of the State to pay for the registration of deaths. There are some reasons why every householder should be compelled to pay for having a death in his house registered. It is for his interest to have it done, and so for the births. The question is one of expediency, to be decided for each locality; but I doubt very much the wisdom of our undertaking to make any formal declaration on the subject, for it would be misunderstood and misapplied.

Secondly, while I do not believe, looking at it from a strictly legal point of view, that it is proper to *compel* a physician to furnish the certificate—certainly not a certificate of anything more than the cause of death—unless he is paid for it, I think it would be exceedingly unwise to approve of the course of any physician who on that ground would resist or endeavor to oppose or subvert the work of registration, which is hard enough to establish without the opposition of the medical profession.

The PRESIDENT. The question is now on the resolution for the appointment of two committees, of five members each, to take into consideration this subject of registration both in cities and country districts.

The question was put, and the resolution adopted.

The Chair appointed the committees, as follows:

On Registration in Cities: Drs. Steuart, Rauch, Briggs, Janeway, and Townshend.

Rural Districts: Drs. Hunt, Ames, Durgin, Thompson, and Lindsley.

The convention then took a recess until 3 o'clock.

The convention reassembled pursuant to recess, and was called to order by the Chair.

Dr. SNOW, from the Committee on Minimum Amount of Information required in Death Reports, submitted the following report; stating that in making it up the committee had found it necessary to include more items than had at first been thought necessary:

"GENTLEMEN: Your Committee on 'the Minimum Amount of Information that should be required in Reports of Deaths' respectfully report:

"We have taken it for granted that the object desired in the reports of deaths is simply for sanitary and statistical purposes, and not for genealogical inquiries. With this view, your committee unanimously agree that the following items of information are necessary and should be required in every report of death in every locality:

"1. Date of death. 2. Name of the deceased. 3. Age, in years, months, and days. 4. Particular location of death. 5. Sex. 6. Color, and with color the race, as Indian, Mongolian, &c. 7. Whether married, single, or widowed, (divorced). 8. Occupation. 9. Birthplace of deceased. 10. Birthplace of parents of the deceased. 11. Place of burial. And in addition to the above the cause or causes of death to be given particularly, as follows:

"'Remote, immediate, and concurring causes.' For example: 'measles and pneumonia,' or 'difficult labor, peretonitis, and septicæmia,' or 'scarlatina, nephritis, dropsy, and coma,' &c. The certificate of cause to be always signed when possible by the name of the attending physician, with his residence.

"It will be noticed that some of the items named above are not necessary for sanitary or scientific purposes, as 'the name of the deceased,' 'the place of burial,' and 'the name and residence of the physician,' but these are necessary to identify the individual so far as to prevent duplicate returns, and so as to refer to the case, if needed, at some future time.

"Your committee have not thought themselves called upon to put these items into the form of a blank return, as the arrangement of the items would depend to some extent upon the manner in which the information is to be obtained, and the decision of this question depends upon the report of another committee and the action of this committee upon it.

"Respectfully submitted.

"(Signed) "EDWIN M. SNOW,
"RICHARD A. CLEEMANN,
"ALFRED L. CARROLL,
"*Committee.*"

Dr. JANEWAY. I move that the report upon the minimum amount of information required on reports of deaths be adopted as the sense of the convention.

Dr. HARRIS. I am pleased with the details. It contains all that is necessary for a complete record, and gives an admirable method for stating the causes of death. There are eleven items in all, eight of which may require some thought and inquiry in making up the record.

Dr. JANEWAY. It is understood that this is the minimum, and that as much more as is desired by any locality can be included.

The report was adopted unanimously.

Dr. STEUART, from the Committee on Best Methods of Securing Numerical Exactness in Returns of a City, submitted the following report:

"Mr. PRESIDENT: Your committee, consisting of Drs. Steuart, Briggs, Rauch, Janeway, and Townshend, beg leave to report the following recommendations:

"First. That all physicians shall be registered in the office of the Registrar of Vital Statistics and their signatures attached, so that their certificates may be duly recognized.

"Second. That the permit system is primarily essential.

"Third. That the physician is the proper person upon whom the responsibility should rest for the certificate and its correctness. In case of no physician, the coroner or some person appointed by the Registrar or by such authority as the laws of different places shall direct must certify to the Registrar before a permit may be issued.

"Fourth. That all undertakers shall be registered at the Health Department or office of the Registrar, and that the signature of both physician and undertaker shall be essential to the completeness of the certificate.

"Fifth. Birth returns: That it shall be the duty of some employés of the Health Department or registrar to call upon every practitioner of medicine once in every thirty days, in order to collect such birth reports as have not been returned under the law of the particular place in question; and that he shall return at once for record all such reports to the Health Department or Registrar of Vital Statistics.

"Sixth. That all midwives shall be registered at the office of the Registrar.

"Seventh. Marriages: It is recommended that an employé of the Registrar shall call upon each clergyman in the city once in thirty days, and obtain from him the names, with ages and nativity, of all parties for whom he has performed the ceremony of marriage. When the law requires a marriage license, the person issuing such license should be required to record upon the license such facts as are required by the Registrar of Vital Statistics, and make monthly returns to the Registrar.

"Respectfully submitted.

"JAMES A. STEUART, M. D.,
"*Chairman, for the Committee.*"

On motion, the report was received.

Dr. CLEEMANN. Is it desirable that the Convention should recommend any conditions of registration for a physician? Every physician who comes to Philadelphia is, under the law, registered; they are asked if they have a diploma of a legally constituted college, and if not, they are not registered, unless they insist upon it, in which event their names are put down. Would it be advisable to recommend to the mayors of cities that there be an examining board in cities which would examine these applicants, so that we could have the foundation of our registration secure?

Dr. JANEWAY. We did not recommend that in the report because there are so many cities where the registration does not call for it.

Dr. CHANCELLOR. Is this recommendation to be presented to the State legislatures, with the recommendation that such a law be passed?

The PRESIDENT. That is to be considered later.

Dr. HARRIS. It is entirely practicable in some of our cities. It has been carried into effect with excellent results in New York since 1866. We could not do without it, in fact. Dr. Cleemann has testified concerning Philadelphia, and in all the cities of Illinois they have this safeguard. I move the adoption of the first recommendation of this report relative to the registration of physicians.

Dr. BILLINGS. There is some danger of going too fast in the adoption by the Convention of these recommendations as presented, and this matter of registration of physicians is one which calls for careful consideration, as it would be at present very difficult to get such registration in many places. Our object is to indicate a minimum of requirement. Does this involve the question of qualification for registration?

Dr. STEUART. The question turns upon the interpretation of the word "physician." Who is a physician? In Baltimore in one case a negro man, who was a graduate of the so-called Eclectic College of Philadelphia, sent in a certificate which he had obtained from somebody else, and it was refused. He brought suit upon the presentation of his diploma, and a mandamus was issued by the judge of the superior court commanding me to recognize the diploma, saying I had no right to go behind his diploma. It is notorious that diplomas from that institution have been purchased all over the world, especially in Europe. My interpretation of the word is that it means graduates of respectable schools. I have recognized the graduates of homeopathic institutions.

Dr. BRIGGS. This clause was inserted at my suggestion and urgent request. In Buffalo we have no system of registration and no method or means of knowing who write our death certificates. My object in having this put in was to indorse the measure, for I propose to recommend it as one of the rules of our Board of Health. We have among those giving certificates some who are graduates and some who are not. The chief object of registration is to locate the men who give the certificates. If it is John Doe, let us have his handwriting, his office and residence, so that if there is anything crooked in the certificate we can put our hand on it. But register anybody and everybody that will come and ask to be registered, only hold them responsible for their acts.

Dr. STEUART. I heartily approve of personal registration. On several occasions I have received certificates signed by the doctor's wife, and sometimes by his medical student. Having his signature on file, like the bank-teller who pays the check and is familiar with the signatures of the depositors of the bank, my clerk recognized at once the strange handwriting, the matter was investigated, and the facts above stated discovered.

Dr. CARROLL. It might be of interest to learn from Dr. Janeway how they manage that subject in New York, where we have a legal definition in the act of 1874 of what a physician is—that he must be a graduate of some medical school, a licentiate.

Dr. JANEWAY. We register those who are regularly qualified physicians. We interpret the law referred to by Dr. Carroll to mean a graduate of a regularly chartered medical college, or a licentiate of a county society recognized by the State. We have also a list of those physicians who, notwithstanding they are graduates of regular schools, or are licentiates, have been guilty of violations of law, as causing abortions, or burying a coffin-load of bricks. The certificates of such physicians are not received, but go to the coroner. I may add that any case attended with unnatural or suspicious circumstances, as a person dying without attendance, goes to the coroner. A midwife is not recognized in case of still-birth. If the child died immediately, at the time of birth, the certificate would be received.

Dr. BILLINGS. It seems that this word "registered" is to be understood by every board and every city and department to suit themselves. In that case there is no objection to it. In some towns and cities it will be necessary to allow anybody who chooses to call himself a physician, and can write his name, to register, stating his qualifications. It would be better to start out on that basis than to have no registration at all.

Dr. RAUCH. Boards of health have no right to decide unless under a special law. Where there is no special legislation with regard to registration any man can register.

Dr. HARRIS. The chief object of registration of medical men is to have the signature of the physician on record, as the bank cashier has the signatures of the patrons of the bank. That is the important point.

Dr. JANEWAY moved the following as an amendment: "That the physician be required to qualify by the laws of the place where he registers;" which was adopted.

The second recommendation was then adopted without change or debate.

The third recommendation was read, as follows:

"Third. That the physician is the proper person upon whom the responsibility should rest for the certificate and its correctness. In case of no physician the Coroner or some person appointed by the Registrar or by such authority as the laws of different places shall direct must certify to the Registrar before a permit may be issued."

Dr. SNOW. Do we mean that the physician is to furnish all the information in regard to name of person, place, birth, sex, parentage, or only the cause of death? If so, it seems to me to be entirely impracticable and unjust to the physician. In New York it appears that the undertakers get all the information. We require directly the undertaker to do this. Undertakers are licensed and registered. We have but few men to look to for the terms, and they are responsible for it. Besides, the physician is very often not in a position to get this information.

Dr. BILLINGS. I move to amend this recommendation by striking out the word "physician," and inserting the words "householder," "head of the family," or "undertaker." I should object to making the physician responsible for anything but the certificate of death. We shall waste the force of the Convention by making a recommendation that cannot be carried out. The locality should determine whether the undertaker or head of the family should be responsible. In England the responsibility rests upon the householder, and it is the same in France, Germany, and Italy.

Dr. SNOW. We say no person shall bury without permit; that includes undertakers and everybody else.

Dr. DURGIN. Is it not possible to so phrase the resolution that it may accommodate the different practices found successful in different cities? We have had no trouble in getting certificates in our own city, yet in other cities there might be a serious objection. If the resolution could be phrased, as I have suggested, to allow in the different cities whatever practice seems to prevail successfully, whether through the physician, undertaker, or head of family, it would meet general approval.

Dr. JANEWAY. If the physician is not made responsible, how does he know that the person whose death is certified to by the undertaker is the person who is dead? Dr. Snow says he relies upon the name and age on the certificate. Then the physician certifies that this person whose name and age is on the certificate, brought to him by the undertaker, is the deceased. The physician thus becomes responsible for the undertaker. He certifies to the correctness of the report of the undertaker. The physician is a more intelligent and reliable man. We make the medical attendant and undertaker responsible. It is the universal rule in New York that the undertaker brings the certificate within the time required by the law and the doctor signs it. It is all on one certificate.

Dr. STEUART. In Baltimore physicians have acquiesced cheerfully. Many have expressed themselves to me as pleased in having a record of cases occurring in their practice in the stub of the book which they have. With us the undertaker practically relieves the physician of all trouble. He is employed to do a certain thing in a certain time, and, knowing that he must obtain a permit from the Health Department based upon the certificate of the physician in attendance, he finds the physician and gets from him the certificate.

Dr. LINDSLEY. Our law requires that the friends of the deceased shall apply to the physician for the certificate and the physician must

not refuse. If an incompetent person comes for the certificate, some one who knows the facts is sent for. The physican really makes out the whole certificate on information furnished by a member of the family.

Dr. SNOW. I wish to correct a mistake of Dr. Janeway in relation to the certificate. He says we make the physician certify to the undertaker. It is a separate certificate. It reads, "date of death, name of person, and then cause." It has nothing to do with the other part of the certificate at all. He signs that and the undertaker presents it to the office.

Dr. HUNT. We had better not pass it exactly in that form, and yet it would be unfortunate not to recognize that the physician has some relation to the whole. As the practice of imposing the duty upon the undertaker succeeds well in Providence and New York, we should call attention to the fact. We may recognize him as having a co-relative responsibility. Parents, &c., should be considered chiefly responsible. I would not decide that it is the duty of the householder, and that the physician has no responsibility; but it would be well if we could modify that so as to include the family without specifying. I would so word it as to show that it is the duty and the interest of the physician to make vital returns, but for the particulars of which returns the parents should be held chiefly responsible.

Dr. BILLINGS. If the householder or undertaker be declared to be the person held responsible for furnishing the certificate for the permit, I am willing to agree that the physician shall be held responsible for the certificate as to cause of death. Our object is to recommend a minimum standard which can be adopted everywhere, and we cannot expect to obtain a perfect system at once. The passage of this resolution would condemn the oldest and best system of registration we have in this country, namely, that of Providence.

Dr. THOMPSON. In your amendment you propose to strike out the word "physician" except so far as the word "death" is concerned. It occurs to me there are several things essential in issuing a burial permit, and the cause of death and the fact of the death are certainly two of these. I can understand how embarrassing it is to a physician to furnish information as to nativity and name of parents, name of mother, and that is the part that the parents or undertaker ought to furnish.

Dr. HUNT. I would offer as a substitute that while the physician must be depended upon entirely for the causes of death, that the parts of such returns as are not scientific and professional shall be furnished by the parents, undertakers, or other related parties, who shall be held responsible for the same.

Dr. BILLINGS. I have not the slightest objection if it can be worded so that the physician may be made one of the responsible parties, or that the undertaker may be made the responsible party, or that the householder may be made one, or that any two or all three of them be made responsible, so as to suit the different laws in different places or cities. If, as we have been told, all these systems work to such perfect satisfaction, why should we insist that only one is the correct one?

Dr. SNOW. Make the undertaker or housekeeper responsible.

Dr. BILLINGS. I would accept that.

Dr. HUNT. I would make the physician chiefly responsible, and parents or other related parties may be also responsible; still it is not best to say that the physician has no responsibility. I consider him ethically and morally responsible for the return of death, and for the return of the cause of death principally.

Dr. DURGIN. It seems to me that if the name, age, cause of death, and duration of disease are given by the physician, and he is made responsible for that portion and no more, and this is returned by the undertaker in connection with his own return, which contains all this other information, there is no chance of mistake.

Dr. RAUCH. The disposition seems to be to relieve the medical man from the performance of his duty. We are dependent upon him for a correct return. The undertaker may not give a correct return. The physician should sign the certificate alone. I am opposed to relieving him from any responsibility in this matter. He ought to know the collateral facts in the case. I am decidedly opposed to any movement or measure that will relieve physicians from the performance of their duty. I do not hesitate to say that we can compel medical men to do their duty in our State. The physician should sign last and look over all the other facts contained in the return.

Dr. AMES. There is no trouble except in cities. The undertaker brings the proof of identification before he gets any certificate.

Dr. CABELL. The question is on the adoption of Dr. Billings's motion proposing the following substitute for the recommendation of the committee:

"That the undertaker or housekeeper or any immediate relation of the deceased should be responsible for furnishing the return of death, including the physician's certificate of the cause of death, to the recorder's office, and that the physician should be made responsible for the certifying to the cause or causes of death whenever asked to do so."

Dr. TOWNSHEND. If the certificate should be presented without the certificate of the physician, would the register be compelled to receive it? If they recommend that, the health ordinances of every city in the country would have to be changed. The undertaker would say that he could not obtain the name of the physician to the certificate.

Dr. BILLINGS. This is all a question of municipal law. I do not seem to be quite understood. I adhere to my point of view, that this convention is making the minimum amount of recommendations to secure uniformity.

Dr. JANEWAY. Then add the words "the minimum," for securing complete death returns, to the substitute.

Dr. HUNT. The trouble is it conflicts with our laws. The physicians in the State might say, "You met in convention with the National Board of Health and decided this question differently," therefore we must not fail to recognize the relation of the physicians to this matter. If we cease to recognize their relation or that they have a responsibility in the matter, we had better give up our whole effort to get vital statistics. The physicians must be the real persons to depend on, either by courtesy or law, to support the matter.

Dr. SNOW. This refers only to cities. I object to recommending a resolution which gives the physician so little to do with the entirety of the certificate, and it is the entirety and unity with us. In Providence it has grown to be hereditary with the people to do this thing in three certificates, but it has not become hereditary with our people, and we have got to recognize that the physician is quasi-responsible, and not release him entirely. I am not anxious for any action upon it, but if we say that this is only for cities, and is the minimum, each place being able to require as much more as it pleases, I do not see the objection to it.

Dr. JANEWAY. Can you not leave out of the substitute the words "when asked to do so?"

Dr. SNOW. I will leave out those words.

Dr. AMES. I confess, while I recognize very much that is admirable in the report and substitute, it seems to me that to settle this great question, as much as our action would seem to settle it at this time, will be a little premature. Things are going on exceedingly well, and each locality is educating its people, and the general advance of sanitary science is still carrying them forward perhaps as fast as they ought to move. I do not believe we are going to help anything by a resolution put in definite form of this shape. Why not let the matter stand? We are educating ourselves, and through ourselves educating others, to about the gist of the views which this discussion has given us. I believe it would be better to leave it where we have brought it, with the influence on ourselves.

Dr. BILLINGS. I withdraw the substitute and move to indefinitely postpone the third recommendation.

The motion was agreed to.

The fourth recommendation was read, as follows:

"Fourth. That all undertakers shall be registered at the Health Department or office of the Registrar, and that the signatures of both physician and undertaker be essential to the completeness of the certificate."

Dr. JANEWAY. Why not put that third resolution in this form: "That a certificate of death signed by the physician, or, in case of no physician attending the person, signed by a properly authorized authority, shall be essential to a burial permit?" The question was taken on the proposition of Dr. Janeway, and it was adopted in place of No. 3, stricken out.

No. 4 was adopted with the addition of the following words: "or person in charge of the funeral," to come in after the word "undertaker."

No. 5 was read, as follows: "That it shall be the duty of some employé of the Health Department or Registrar to call upon every practitioner of medicine once in every thirty days, in order to collect such birth reports as have not been returned under the law of the particular place in question, and that he shall return at once for record all such reports to the Health Department or Registrar of Vital Statistics."

Dr. BILLINGS. This would not by any means get all the births. At many births physicians do not attend. Some are attended by neither physicians nor midwives.

Dr. STEUART. The object of this was to get returns particularly from leading practitioners of medicine. In almost all cities they are the most negligent. In Baltimore there are twenty or thirty who stand at the head of the profession who are the most negligent in making returns of births. The midwives are very prompt in making returns. The number of those who are born without the attendance of either midwife or physician is comparatively small, and if we lost only those we would have a very large return.

The object of this is to get those who are attended by physicians, by calling upon them, to jog their memories in a mild way, to say, "Doctor, you have forgotten to make the return of the births you have attended during the month, and the Health Department has sent me to request that you will give me a list of them in order that they may be recorded." It was the suggestion of Dr. Janeway, who has had a great deal of experience in New York with the same difficulty, and the committee unanimously accepted it.

Dr. JANEWAY. Of course we have a law on the subject. It is the duty of each person at the birth to see that somebody makes a record of the birth at the proper place. The Health Board or Registrar has some employé who goes around and collects from midwives, &c., those which have not been returned according to law.

Dr. MEAD. In my opinion it is a mistake to make more than one person responsible. What is everybody's business is nobody's business. If the law specifies that one certain person shall be responsi-

ble for the report of a birth you will get more of them than if you make half a dozen persons responsible. Suppose you make father, mother, physician, midwife, and the persons looking on responsible. It is manifestly unjust that you can prosecute all these persons. I would recommend that but one person be held responsible for these returns.

Dr. CLEEMANN. All these people are not to be made responsible at once, but where one fails to perform the duty the other must. If a physician is present, he is responsible. If neither physician nor midwife is present, then the parents are responsible. That is the Philadelphia regulation.

Dr. RAUCH. The Health Department at Chicago does not record the births; they are recorded at the office of the county clerk. That obtains with regard to the entire State. We have about two hundred midwives in the city of Chicago. They are the most prompt, and they return all the births they have. In certain counties of Illinois people go to the county clerk and wish to make returns of births. It is a question of education. I think a great deal of good would be accomplished by this recommendation. In those places where there is no medical man we have been trying to educate the people up to the idea that it was important from a legal stand-point that the record of births should be made. And that is the course we pursue in order to increase our registration returns.

Dr. SNOW. What do you mean by a return of birth in this recommendation of the committee—what information is required?

The sex, color, place of birth, street, number, father's name, age, occupation, father's birthplace, mother's maiden name, age, and birthplace, all these particulars we think to be important, and we get them in full. For twenty years past, in Providence, I do not believe there has been an average of twenty missed in a year. We send a person to take the census from house to house twice a year. The persons employed go to every family with these blanks bound in books—100 in a book—to inquire of the mother or other responsible person all these particulars which they can get without much trouble, except in some exceptional cases, as illegitimate children. Then we put at the bottom the name of the person who gives the information, whether mother, sister, &c. Under these circumstances we get almost complete returns of births, and our births always exceed our deaths. The expense is not large. The same plan obtains in Boston and in all the large cities in New England. In our country towns the census is taken once a year. In Providence it is taken twice a year. We, of course, miss some who have moved away, but we get others who have moved in, so that the whole number is very nearly the exact number. The discrepancy cannot be avoided until we have the English system of local registrars for every two or three hundred persons.

Dr. BILLINGS. Twenty years ago Dr. Snow presented a report to the National Sanitary Convention which met in Boston (which report was adopted), in which the form of a registration law was given as follows:

"(The following portions of an ordinance are based upon the supposition that the State legislature has conferred upon cities the power to make ordinances upon the subject, and that it has also made all necessary laws for the regulation of marriages and for preserving the record of them. The ordaining clause and other particulars must be changed to meet the wants and customs of each city.)

An ordinance in relation to the registration of births, marriages, and deaths.

It is ordained by the city council of ————, as follows:

SECTION 1. A City Registrar shall be appointed by the Board of Health, who shall be a well-qualified graduate in medicine, and who shall hold his office for the term of ——— years, from the 1st day of January next after his appointment, unless sooner removed by the Board of Health.

SEC. 2. It shall be the duty of the City Registrar to keep a faithful record of all the births, marriages, and deaths in said city, in accordance with the laws of the State and in accordance with such regulations consistent with such laws as may be made from time to time by the Board of Health.

SEC. 3. It shall be the duty of the City Registrar semi-annually in the months of January and July to obtain by a census from house to house and to record the information required in relation to all the children in the city who have been born during the six months next preceding.

SEC. 4. The City Registrar shall furnish to the Board of Health at any time such information as they may require in relation to the returns of deaths or any other subject connected with the duties of his office. He shall also, annually, in the month of January or February, prepare a report in relation to the births, marriages, and deaths in the city during the year ending with the 31st day of December next preceding, with such tables and observations as he may deem important and as may be required by the Board of Health.

SEC. 5. The Board of Health may appoint a sufficient number of qualified physicians as Assistant Registrars in each ward of the city, whose duty it shall be, as hereafter provided, to grant permits for the burial of the dead and to make an examination in cases where no physician's certificate of the cause of death can be obtained.

SEC. 6. No person shall bury or place in a tomb or remove from the city for burial, or otherwise dispose of the dead body of any human being who shall die in the city, without a permit first had and obtained from the City Registrar or from one of the Assistant Registrars.

SEC. 7. No permit shall be given as provided in section 6, until the Registrar or Assistant Registrar is furnished with the information required for record in relation to the deceased person, so far as the same can be ascertained, together with the attending physician's certificate of the cause of death, whenever it can be obtained, or a coroner's certificate whenever a coroner's inquest has been held. Whenever a permit for burial is applied for in a case of death without the attendance of a physician, or if it is impossible to obtain the physician's certificate, it shall be the duty of the Assistant Registrar in the ward in which the death occurred, to visit and view the body of the deceased person, and to make all necessary inquiries respecting the death, and when he has obtained satisfactory evidence in relation to the cause and circumstances of the death, he shall sign the certificate, and give a permit for burial. If not satisfied in relation to the cause and circumstances of the death, or if, in his opinion, the public good requires it, he shall report the case to a coroner for investigation.

SEC. 8. Whenever a person shall die in the city under the care of a physician, it shall be the duty of the physician attending in his or her last sickness, to furnish to the undertaker, when requested, a certificate, giving the name of the person, the date of death, and the disease or cause of death.

SEC. 9. No person shall carry on the business of an undertaker, or bury, or place in a tomb, or remove from the city for burial, the dead body of any human being without a license first had and obtained from the Board of Health, and the Board of Health shall have power to revoke and annul any such license at their discretion.

(There are many other items which would be necessary for a complete ordinance upon the subject, the precise nature of which would depend upon the local circumstances and wants of each city. Some of these are the following: the salary or fees of the City Registrar and of the Assistant Registrars, the employment of clerks, provisions for the preservation of the records, penalty on physicians and undertakers, and a statement of the items of information to be obtained. I would also recommend that a small fee be allowed to undertakers for making returns of death.)"

Dr. SNOW. Our law, as it was passed, authorized the Registrar to pay not exceeding fifteen cents for each report of birth, and then he afterward receives ten cents for recording it, making it an object to the Registrar and town clerks in all the towns, both for the fees of getting them and recording them. But my experience in doing it is this, that it is very easy to obtain persons to do it for much less than that. I think in a city I could get perfect returns by skilled persons if the census were taken once a year for seven cents apiece, or for ten or eleven cents if twice a year. In some of the towns of Rhode Island they have lately adopted a plan which I do not think is satisfactory, namely, hiring some one to collect these returns at a fixed price. They hire the assessor. I do not think it is as well as paying separately for each case. We have three censuses, namely, the census of school children and of the militia and of the children born, which are taken by the same persons, and makes the expense slight. I have employed from seven to ten persons, one in each ward, and they take the census in a week.

Dr. RAUCH. The changes in a city like Chicago would make such a difference that it would be almost impracticable to carry out Dr. Snow's system. It will do for a fixed population, but not for large cities, unless you do it every month.

Dr. AMES. There is one addition to that recommendation which ought to be brought in here, and that is an obligation on the part of the householder to report every birth within his domicile. I am aware that many persons are so ignorant of laws that it will be a long time before they are educated to believe that it is incumbent on them to report, but I am satisfied in the case of a shifting population there must long be a large percentage escape us unless such a provision is incorporated. In my own town, which has a population of 6,000, my own child was omitted from the registration of births. My wife and myself were a little piqued at the matter, and we thought we would find out how many had been omitted. We take the enumeration there but once a year. We found that 22 infant children had not been registered. That is only an illustration on a small scale of what would occur on a larger scale in larger cities.

Dr. JANEWAY. I do not suppose any city in the country has full birth returns. It has been supposed that the birth returns are full and accurate in New York; but they are not. I do not suppose the present system will ever get them complete. What are you going to do? You have got the law. The law in New York holds everybody responsible who is present at the birth for seeing that some one records it. And what has been the result of it? In New York city at least one-third of the births are not recorded. How are you going to succeed? The only way I know of is to supplement the law. You have got to let the law stand; it is the State law, providing for New York City, Brooklyn, and other places. Now, in addition what can we do? That will be the only additional measure that will be apt to get any considerable increase in the number of births recorded. Whether it is the best thing for every city in the country is another question.

Dr. HUNT. If the matter is to be decided this evening I am sure that the idea of Dr. Snow is the correct one; and yet as I suggested this morning in most of our cities it will not be possible to take an extra census in that way. I do not believe we shall accomplish so

much, however, as to recommend that the boards of education, which are very perfect in most of our cities, shall, at the time they make an enrollment of the school children, also make such an enrollment as will furnish us with the names of children under one year of age. I believe that at present that is far more practical than the other plan suggested.

Dr. Rauch. That may answer in New Jersey, but not in other States.

Dr. Snow. Any such recommendation would not apply to us at all. I think there would be no difficulty in regard to the expense.

Dr. Steuart. Dr. Hunt's idea of getting returns from the board of education would simply ascertain the number of births in a given town or place, but there would be no registration of the name, of the date, or of other facts which are of importance in the registration of births.

Dr. Cleemann. One difficulty would be this: we know in the first year of life the mortality is very great, and if they should get around once in six months a great many infants would have perished, and they would not be registered.

Dr. Hunt. They would appear in the death returns.

Dr. Billings. I concur with the remarks of Dr. Rauch. The plan would work better in Providence than in one of our western towns—in a town where there is very rapid immigration, emigration, or both. I agree also that the householder should be made the responsible party and compelled to report the births, just as I would have him compelled to report all deaths taking place on his premises. My own conviction with regard to this is very much the same as with regard to the death certificate, namely, that it had better be indefinitely postponed.

Dr. Snow. I perfectly agree with that idea, but still it seems to me that this convention has met especially to consider the subject of registration, and if we had given this committee six months or a year instead of an hour and a half something might be framed which would be valuable.

Dr. Cleemann. Although the resolution is not perfect, it is the best we can think of now. It is better that we should pass this now than to let the whole matter go by default. This resolution will accomplish a good deal. I think in Philadelphia we lose 20 per cent by the method; still it is the best method we know of.

Dr. Janeway. I prefer postponement. We do not know exactly what the laws of the different places provide. The education law might not work in New York City. I do not know that they would have the power to adopt this plan, and I know they would not have the money. I suspect the same would be true of other places. I think the best thing would be to carry out the laws as they exist with such additions as in each case the experience of the health officer dictates.

Dr. Hunt. I desire to withdraw that amendment. I think the resolution as we have it will do no harm. It at least facilitates, helps out the present method, and while it cannot be regarded as perfect it will be better than to have too many postponements.

Dr. Billings. This does not give any registration, it gives a count of births. These births thus obtained cannot be "registered" in any proper sense of the term.

The words "in such places as physicians are required by law to report births" were adopted, to come in after "medicine" in the fifth recommendation, and the recommendation, as amended, was adopted.

The sixth recommendation was read, as follows:

"That all midwives shall be registered at the office of the registrar."

Dr. Snow. Do you make this recommendation for all places? There are very few places where midwives are required to report. Hardly more than where censuses are taken. I think perhaps there are more who take by census. In all our towns in Massachusetts this would have no application.

Dr. Rauch. We treat midwives in Illinois as we do doctors.

Dr. Steuart. The midwives think it something of an honor to be recognized by the health department.

The following words were adopted, to come in before the words "all midwives":

"That in all places in which midwives are required by law to report births."

The sixth recommendation, as amended, was adopted, as follows:

"Sixth. That in all places in which midwives are required by law to report births all midwives shall be registered at the office of the Registrar."

The seventh recommendation was read, as follows:

Seventh. Marriages.—It is recommended that an employé of the Registrar shall call upon each clergyman in the city once in thirty days and obtain from him the names, with ages and nativity of all parties for whom he has performed the ceremony of marriage.

When the law requires a marriage license the person issuing such license should be required to record upon the license such facts as are required by the Registrar of Vital Statistics and make monthly returns to the Registrar.

Dr. Hunt. In our State there are large cities that are returned without any difficulty. The clergy give us no trouble. If we made this a duty it would be exceedingly unfortunate for us.

Dr. Snow. That is just our case.

Dr. Janeway. I move the recommendation be stricken out.

The motion was agreed to.

The report of Dr. Steuart, as amended, was then adopted as a whole.

Dr. Ames. On behalf of the committee on measures for securing the most complete returns of deaths, births, and marriages from territory outside of cities, I have to submit a report.

On motion the report was received.

On motion its consideration was postponed and the convention adjourned to meet May 7, at 10 o'clock a. m.

May 7, 1880.

The convention met pursuant to adjournment, Dr. Cabell in the chair.

REPORT ON METHODS OF SECURING RETURNS OF DEATHS OUTSIDE OF CITIES.

The report was read, as follows:

"The committee on measures for securing the most complete returns from territory outside of cities upon deaths, births, and marriages are of the opinion that owing to the widely varying conditions as to the existence, status, or location of proper returning officers and even of physicians in the different States and in different parts of the same State, the determination of those who shall sign and receive certificates must depend upon special enactment for the several localities. In a general way we believe that the underlying principles which obtain as to cities and have already been expressed should be recognized as far as possible in the less densely populated or outlying districts. We also believe that everywhere it is both the duty and interest of the profession to make mortality returns, but for the parts of such returns as are not strictly scientific and professional, parents, undertakers, or other related parties should be chiefly responsible. We believe that in all cases (excepting only those in which the most insurmountable obstacles temporarily exist) the *Returns of the Deaths* should be made before burial (under penalty) to the legally constituted authority; and that the certificate of the attending physician (if any) should be a part of the return. It will be remembered that in certain sparsely-settled regions no accessible officer except an assessor exists in a wide circuit to whom returns could be made. Circumstances of death in country districts frequently arise also in which no undertaker, relative, or near friend exists and the neighbor must perform the last offices for the dead. We believe, therefore, that the person who in any case acts as and performs the functions of undertaker should be held responsible for the return of the non-scientific facts in the case, and in the absence of any attending physician, we believe that a country physician or coroner should be summoned at once to certify to the probable cause of death. In short, we believe that in the State at large as in the city the surest, indeed the only, reliance for complete knowledge of all deaths must primarily be upon antebural returns to some responsible and accounting official.

"For the present we fear that for the Returns of Births we must mainly rely upon the returns of attending physicians or those officiating as such, though we think it would be a valuable adjunct to completeness to enlist the aid of the assessor, whose returns would at least greatly aid in the verification of or the discovery of discrepancies in the original returns.

"For the Returns of Marriages there is apparently ample security for completeness in the returns of the clergyman or officiating officer if sufficient penalty is attached to failure or neglect.

(Signed) "E. M. HUNT.
"AZEL AMES, Jr.
"S. H. DURGIN.
"PINCKNEY THOMPSON.
"CHAS. A. LINDSLEY."

Dr. Billings. I think "vital statistics" would be a better phrase than "vital returns."

Dr. Hunt. Importance is attached to it as a matter of record. We could get a great deal more from our legislature under the title of "vital records" than under the title of "vital statistics."

Dr. Snow. I think it is evidently not correct.

Dr. Ames. With the consent of the committee I will insert "mortality" instead of "vital returns."

Dr. Snow. I understand very well that there must be difference in the manner of collecting returns in the country from that in a city, and that there are difficulties in the way which do not obtain in the cities. By this report we are to depend on the physicians for the reports of births, and supplement by that assessors or other persons who visit the people. I would like to change the order of the recommendation, and say let us depend upon the assessors' returns, and let them supplement them and correct them by the help of the physicians. That is the same as they are doing in the United States Census with mortality. It is proposed to collect the returns by the enumerators, but at the same time the physicians have been furnished with blanks, and the enumerators will correct their returns by visiting physicians and getting all the information they can in every case so as to make them perfect as possible; and I would much prefer that plan in regard to the births. The difficulties of collecting these statistics I do not think are fully understood by this convention. It seems to be a formidable task to take a census and collect these facts; but in Providence it is found to be simple and inexpensive. In every

country town in Rhode Island they are collected in that way at the end of the year. It would hardly pay in small towns to collect twice a year; but in the most sparely-settled towns in the State they are collected, and collected at an expense of less than ten cents each, and collected with all the particulars which would be very difficult to get from physicians. I would like myself to depend, first, on the collection by assessors or some other person at the beginning of each year, and then that these assessors be directed to correct and fill out their returns by the help of physicians.

Dr. CABELL. That is the law in Virginia, but badly executed.

Dr. HARRIS. In the State of Vermont, in which registration is as perfect as in any place where there is not a special registrar, the Secretary of State has, through the school district clerk, made an almost perfect registration. I am informed by him that scarcely 1 per cent. in the last ten years have been omitted from the registration of births. There the assessor would not be as available as the school district clerk. It might be found in different States different classes of officers are available. In New York probably the school district clerk at present would be more available than the assessor.

Dr. HUNT. We recognize the fact that some form of census is best to be had every year; that that is the best way of collecting births. I do not see, with both the laws and methods different in different States, how we can come down to any one plan and say that one plan is best for all the States. In our State we have the assessors, who very frequently call on the physicians in addition. I think when we come to make it the duty, in connection with the school enrollment, to have every district clerk get the facts every year, we shall have a perfect system. Now, I do not believe that would be the best system for Rhode Island. They have a better system. If they can succeed in convincing the legislature it is best to to have a census twice a year, and have it as they are making it, that is the best plan for them. It would not be a good plan in our State. Though it may be said the expense is small it is adding one expense to another. If we should add an expense of even five cents or three cents, that of itself would kill the bill. Therefore, it seems to me that the legislation as suggested by the committee is advisable to be carried out.

Dr. RAUCH. I think it very important that care should be exercised in the recommendations made by this convention from the very fact that it is utterly impossible to apply the same law to every portion of this country. As an illustration with regard to our State, when the registration law first went into effect, some of the counties made the doctors pay for the blanks they had. The idea was that the medical men took great interest in this matter, and I do not hesitate to say that they are more directly concerned in it than anybody else; at least such is the case in our State. It was some time before I could impress the county clerks with the importance of getting returns. Some of them appreciated it in the outset. The older county clerks all appreciated the necessity of this work, for they have been called upon for records which they have not been able to get. We have in our State a great many foreigners. In certain counties there are parties who know about this system of registration. They go to the county clerk, if they have no physician, and make the return themselves. In the course of time the whole community will be educated in that way. Some of the medical men think they ought to receive compensation for it. Some will make that point. Therefore I think it a matter of the utmost importance that care should be taken not to strictly recommend one plan. It would do more harm than good.

Dr. AMES. Recognizing exactly what has been said by Drs. Hunt and Rauch as true throughout, recognizing the full force of what Dr. Snow has said, the first thing that is necessary to find is some one party who everywhere exists, if you are going to establish uniform completeness. The only party who everywhere exists is the head of the family. If we would suggest the best source for complete returns we would go to the householder—make it obligatory upon him to make the return. I for myself am satisfied that is where the first responsibility should rest. But we all know how difficult it would be in the remote counties of the Southwest and elsewhere where there are numbers of foreigners, how impossible it would be to make them realize that the law required of them that the return of births should be made within ten or fifteen or thirty days after occurrence. That would be the real thing which we want, but it cannot be done in our Western cities. It is useless to expect these foreigners to make returns because they do not know the law and therefore cannot comply with it.

Then who is the next best person. Why you have everywhere an assessor. There is no other officer who always and everywhere exists. I am not sure but that the point raised by my friend, Dr. Snow, is not well taken, that the assessor should stand first. Then comes the physician. I think if the gentlemen of the conference will think of it they will find that there is no other officer who suggests himself as being omnipresent who could make this return. The doctor can play primary or secondary part as in each locality seems better.

Dr. CARROLL. It seems to me that the two things which were really practicable with regard to securing uniformity we have already determined upon with regard to deaths. We have agreed that a burial permit should be the fundamental demand everywhere. We have also agreed upon the minimum form of information upon which it should be required. Beyond that I think it must be evident to every gentleman here that uniformity in other methods of procuring vital statistics would never be reached if we were to take six months. Every gentleman of course looks at it from his own *genus loci*. It is so manifest from all that we have heard that the local machinery of State laws differ so greatly that I should like to move the following with a view of bringing the discussion to an issue:

Resolved, That whereas the methods of collecting vital statistics must necessarily vary in different States and localities, the determination of the nearest approach to uniformity and completeness which can be recommended for such purpose be referred to the National Board of Health.

It seems to me that after hearing the views of gentlemen from different parts of the country the National Board of Health would be the proper body to determine how near an approach to uniformity can be made for the purposes which we have in view.

Dr. CLEEMANN moved that the report of the committee be adopted.

The question was put and decided in the negative.

The question then recurred on the resolution offered by Dr. Carroll.

Dr. HARRIS. I wish the resolution had been extended to include the word completeness.

Dr. CARROLL. I accept the amendment.

Dr. HARRIS. This matter of getting returns with any degree of completeness depends largely upon public opinion, and the National Board of Health, through its correspondents, will have opportunity to get this. Again, the popular idea is that our birth-rate is very small, and that we are dwindling at this end or the other of the Union. This opinion I suppose is quite without any basis. Our nation has become great and strong by virtue of its anthropological development, its physiological character, as it may be said. It is certainly remarkable this intermixture of races of the civilized world. This subject, as it may be worked up through the various public-health authorities and by the National Board of Health, is going to be one of the means of awakening interest in our real condition as a people.

The question was taken, and Dr. Carroll's resolution adopted.

IV.—REPORT ON SUMMARIES AND ABSTRACTS.

Dr. HARRIS. The committee reports briefly upon summaries and abstracts, weekly, quarterly, &c., as follows:

The committee to whom was referred the fourth division of the schedule of subjects would report that under the following heads the results of their deliberations can be most conveniently submitted:

PERIODICAL SUMMARIES AND ABSTRACTS.

1. Weekly and monthly.
2. Quarterly.
3. Consolidated annual.
4. Sanitary observations in the periodical statements or bulletins.

The value of the summary and total statistical statement which should be made periodically or otherwise by registering and sanitary officers concerning vital statistics, will ever depend upon the accuracy and completeness of the individual parts or units in the whole mass of facts registered. The abstracts of records of mortality should present simply those facts which are essential to a correct view and comprehension of the relations of the various causes and classes of causes of death, with the sexes, nationality, and civil and social conditions.

The comparable relations of any or all these points in the mortality records to other statistical facts in the registry of human lives need to be exhibited in suitable ways and at proper intervals, but the first summaries of records of death, whether weekly, monthly, or quarterly, are best studied with reference to what they may in themselves exhibit in their relations to local and the general causes of death, and of the influences and conditions which enter into the causation of diseases and the indications which are supplied concerning the means that should be applied to diminish and prevent disease and premature death.

In great cities and other compact communities, and in the presence of an epidemic anywhere, the review of the records of causes and circumstances of death in any place, and by every registry and health officer, is a duty which ought not to be neglected for a single week nor for a day. But for correct statistical study, and for safe and most practical conclusions regarding the indications given by the mortality records concerning local, personal, preventable causes, and the sanitary duties which should be brought to bear, it is necessary to bring the daily, weekly, and continuous observations into close order, and after proper arrangement of them and comparing such facts as are comparable, make the most practicable study and deductions that may be possible at the expiration of each month. We therefore recommend that the monthly review and statistical abstracts of the records of mortality in every bureau of vital statistics and in every board-of-health office shall be regarded as an indispensable duty, and that in every city and township, and in whatever county, precinct, or parish where there is a local bureau or office of registration of deaths, the monthly review of the records shall be maintained in accordance with methods that shall be sufficiently uniform for comparison with similar abstracts and reviews in the cities and States throughout our country.

The outlines for suitable forms for a monthly abstract and review are here submitted (see forms so entitled), and they are respectfully recommended for use by all concerned. As regards the review and

conclusions that may be affixed to each monthly abstract and bulletin, it is important to bear in mind that the tendency to strain results and deductions from a limited amount of statistics and from events of too brief a period should be avoided. This must be remembered by all who prepare the periodical bulletins and published statements relating to records of mortality.

For a weekly bulletin the committee recommends that the form of abstracts be simple, and that such bulletins be comparable with those of the chief cities and the National Bulletin, as shown in the form for the monthly abstract herewith submitted; any more extended statistical statements to be in accordance with the wants and preferences of the local sanitary authority.

QUARTERLY ABSTRACTS.

These should comprise records of birth and marriage, if such records are as promptly registered as those of mortality; but where not so registered the comparison of these two branches of records has to be postponed to appear in the annual report, in their monthly and quarterly relations, and be so arranged as to appear as delayed one quarter later than the mortality records for quarters as published.

The annexed outlines of such an abstract for the quarterly report of the registered mortality in each city and State are here submitted. The proper columns are arranged for the statement that may be made of the records of birth and marriage.

The first object of the quarterly abstracts is to aid in consolidating all the records for the most convenient and comparable review, and the second object is to induce useful study of the varying seasonal and special causes of mortality and at the same time aid in preparing the basis of the annual report. It is not necessary that the list of diseases and other causes of death should be complete in the quarterly exhibit, yet in every such exhibit it is important for practical ends that the totals and distribution of classes of causes by age, sex, and race shall be stated, and that the various causes defined in Division "A" of the General Diseases should be given in full details. As from fifty to one hundred and fifty names of causes may be entered and printed on one face of a small sheet with as much economy as a less number, it will be well to have the quarterly abstract as full as such a long page will allow. Grouped in classes the list of causes of death is readily reported in a satisfactory manner by enumerating the chief causes in each class and entitling the total of those not recited in the printed list as other causes in this class.

THE CONSOLIDATED ANNUAL REPORTS.

The quarterly and monthly abstracts facilitate the preparation of a correct consolidated annual report. Whether every registered cause of death is entered in this report or not, the classes and subdivisions "of others," as grouped, will be correctly entered. But this report should be as complete in its detailed list of the causes as the printed limits allow.

The annual consolidated abstract and report of vital statistics, accompanied by sanitary observations for the year, should be completed and published as soon as practicable after the close of the year to which they pertain; but a summary of the year's records of mortality can be very usefully published within a few weeks of the close of the account for ready exchange and other public uses.

THE SANITARY OBSERVATIONS

(weekly, monthly, quarterly, and annual), as now practiced by the ablest authorities there, should be pertinent observations upon—

The prevailing diseases, especially the general diseases and the zymotic groups;

The mortality of children at particular ages and by preventable causes;

The deaths by bronchitis, pneumonia, and other pulmonary diseases, especially phthisis; and

The deaths by violent and unusual causes and whatever else in the records of mortality diseases the public should be concerned about.

All of which we respectfully submit.

ELISHA HARRIS.
EDWIN M. SNOW.
STEPHEN SMITH.

On motion the report was adopted.

Dr. BRIGGS. Probably the able report which we have just heard is as important as, or at least next in importance to, the matter of nomenclature which we are called to consider principally. But it is a matter that is going to take a great deal of time. I move that this matter be referred to the National Board with the request, I will not say instruction, that they print this report and these blanks with suitable comments, and mail them to the different Boards of Health and Registrars of Vital Statistics with such recommendations as they think may be practicable. I also move that all other matters that we have left in an unfinished state, such as the reports of the two committees, be referred to the National Board of Health.

Dr. BILLINGS. One of the most difficult problems, after you have got your data, is what to do with them, and how far the Registrar or vital statistician should endeavor to work up the data and draw the conclusions, and how far he should endeavor to present them in such shape that they may be worked up by others.

Dr. SNOW. Uniformity of tables, so that anybody can use them, is the most important part. There is no State or city in the country that will carry this out in making a table in every way desirable. If we can get certain tables giving all the facts, I should hope sometime, in connection with the National Board of Health, that they would be made use of—much greater use than by any other means perhaps. The motion is that this matter be referred to the National Board of Health, and I hope it will pass.

The question being taken on Dr. Briggs's motion, it was carried.

V.—METHODS OF REVISION AND PERFECTING OF THE INDIVIDUAL RECORDS (THE CERTIFICATES)—(1.) IN CITIES, TOWNS, COUNTIES, STATES—(2.) WHO SHALL BE THE EXPERTS IN SUCH DUTY.

Dr. BILLINGS. That section refers to the methods in use in France and certain other countries for verification of the causes of death by officers appointed for that purpose. It seems to me that it is of very little interest in this country, as it would be utterly impracticable to carry it out now. Whether we shall ever come to that or whether we shall ever have any real necessity for it, I think is doubtful. It does not seem to me that any action is necessary on the part of this convention at the present time.

Dr. CLEEMANN. I suppose the Health Officers do, in all the cities where there is any doubt, look into the subject. We do so in Philadelphia. If the death certificate appears to be incorrect the physician is written to, and that is one reason we have him put his address on the certificate. If the answer is not satisfactory we send a medical inspector, who inquires into the cause of death. Sometimes he is met roughly by the physician, but still the law is always enforced, and if there is any difficulty at all a coroner is called to find out the cause of death.

Dr. DURGIN. In Boston we refuse a permit to bury until the certificate has been made satisfactory. If there is no suspicion of anything wrong about the certificate then permit to bury is given, but the Board of Health reserves the right afterward to consult the physician who made the certificate and have any error rectified before the certificate is recorded. In case a certificate looks at all suspicious we either send the undertaker back to ask further questions of the physician and have the certificate revised, or else turn it over to our city physician, who is at hand, for him either to indorse the certificate with his own signature, or it is sent back and the burial permit or the approval of the permit of the Board of Health withheld until it is made correct.

Dr. MEADE. That is the course to a certain extent in the District of Columbia. If a certificate comes in which seems suspicious a permit to bury is refused. But in case of a mere informality about the certificate, of course we do not refuse.

Dr. BILLINGS. I suggest we pass over this; it does not require any action.

The motion was put and agreed to.

VI.—STATE AND LOCAL LAWS.

Mr. COBB. I wish to offer a resolution to the effect that the National Board of Health be requested to prepare a form of health statute to be recommended to State boards and local health authorities for adoption. My object is to obtain a codification of such laws as already are in existence, and adopt similar laws for the State of Florida, so that the laws of Florida may be uniform with those of other States. I want to get a sanitary law and statistical law combined. I think it would be more effective with us if we could get them combined.

Dr. HARRIS. I propose to move, if Mayor Cobb accepts the change of phraseology, that a similar committee be designated of the National Board of Health, to prepare an outline for such public-health laws to best promote the establishment of State and local boards of health.

Dr. CABELL. That seems to me totally unnecessary in view of the fact that the Public Health Association is doing that work.

Dr. BILLINGS. Speaking now from the point of view of a member of the National Board of Health, I must say that this resolution would impose a very difficult duty on the Board. It could only report a series of alternate systems, any one of which will be found to work well in certain localities. I have no information which would lead me to approve the system of sanitary legislation and of collection of vital statistics, now in force in Massachusetts, to the exclusion of all others. This country is not by any means a homogeneous whole; we have all sorts of climates, and all sorts of people, as to education, habits, commercial relations, &c., and I think that for a long time to come we shall have to let them work out their salvation in their own way, simply trying to get them to agree upon a few points, so that some of their data will be strictly comparable, and in the hope that they will come more and more together. Every State Board of Health is an experiment. Not one of them is exactly satisfied with its present duties or powers. The National Board of Health have been trying to get a complete collection of the sanitary laws of this country, including not only statute but judge-made or common law. We want to have all these printed for comparison and discussion, but it is too soon to attempt to prepare a uniform law.

Mr. COBB. I think the wisest course would be for me to withdraw that resolution. I will therefore withdraw it.

Dr. DURGIN. The convention has voted on certain facts that should be obtained for registration, and we have already voted to refer to the National Board of Health the matter of tabulating, print-

ing, and circulating the same to the several statisticians and boards of health. When we have gone home and received those, we shall at once see the facts that are required. In many places the law stands sufficient and ample to cover all of those facts. In those places there will need to be no new legislation. In other places there will be needed perhaps a moderate amount. In some others still, where there are no laws which call for these facts, there will be need for entirely new laws, but it will be seen by statisticians what they need to call for in their own States.

Dr. HARRIS. I move this topic be withdrawn from further consideration.

The question was put and the motion agreed to.

EFFECT OF DEATH-RATES UPON LIFE INSURANCE.

Dr. CABELL. In the matter of these statistical tables, it is important for the insurance companies to know as far as possible what proportion of deaths occur among the actual residents and what proportion from floating population, so that they can distinguish between persons acclimated and those not.

Dr. BILLINGS. That will be done to some extent in the next census. The length of residence is to be noted by the enumerators in the mortality schedules. I wish to ask Dr. Curtis whether any of the insurance companies attempt to make a discrimination in their rates according to the mortality rates of different cities. For instance, in the city of Memphis can the average healthy man of twenty-five years of age insure his life at the same rate that he can in Charleston?

Dr. CURTIS. No, sir.

Dr. BILLINGS. If that fact were understood, and it was known that a death-rate of say forty-one per thousand meant an increase in the insurance rates for that place, it would exercise a very powerful influence in sanitary matters.

Dr. RAUCH. I have no doubt it would be a powerful motor, but I do not think insurance companies draw that distinction.

Dr. CURTIS. In the Equitable, of New York, we have a special rate for southern cities below a certain line. Many companies do not insure at all in Memphis. We make no discrimination in the northern cities, nor do we take into consideration the sanitary condition of a city as shown in the death-rate.

Dr. BEMISS. The increased death-rate might be due to that class of people who do not usually insure. I should think that question would come in as a business point.

Dr. CURTIS. In northern cities no discrimination has been made as yet in insuring. The discrimination has always been in southern cities and southern districts. In some such glaring cases as Memphis the companies hesitate to do business at all. When a person is going South he has to get a special permit to visit during certain seasons of the year.

Dr. SNOW. Before insurance companies act on statistics we should want accurate figures. For instance, Saint Louis gives a death-rate of but twelve to the thousand and New York some twenty-three or twenty-four, yet I suppose New York is as safe as Saint Louis.

Dr. HARRIS. I think the end Dr. Curtis would seek in the interest of insurance is in a measure obtainable. It has been brought up and very ably discussed in one of the German sanitary conferences; also the question whether strangers and non-residents—what you call the floating population—may not be separated in the statistics has been discussed in different statistical conferences. I think one inquiry that should be made is, what becomes of the child population, and what is the cause of this immense mortality in particular localities. It was found on examination that the cause of the enormous death-rate of Cleveland was the great mortality among its children; and very often you will find that the large death-rate of a city is due to the great mortality among its children.

Dr. RAUCH. That question attracted my attention in 1868, and I separated then those of native and foreign parentage. In my weekly mortality reports I always called attention to those who were of native and those of foreign parentage. The infantile death-rate of the city of Chicago is probably larger than any other city of the United States, and the only way I can account for it is that the population is younger and more vigorous. In regard to Saint Louis I must confess that I have frequently been staggered with regard to their registration reports, and I have been watching Saint Louis with a great deal of care and interest for years, but I do not hesitate to say that the death-rate is low there, although I think they make it lower than it really is by overestimating their population. I have found, however, that during attacks of certain diseases—cholera, small-pox, &c.—as a general rule their death-rate was higher than that of Chicago. For instance, in 1866 the death-rate by cholera in Saint Louis was greater than in Chicago. Several weeks ago I was in Saint Louis, and the health authorities there gave me facilities for inspecting the city and looking over their sanitary condition, and I was very much pleased indeed. I am satisfied their death-rate is low. I have examined their burial permits and their system of registration, and as far as I could see I could take no exception, and the only way I can account for it is that the general health of Saint Louis is good really and that they have over-estimated their population.

Dr. SNOW. Every one acquainted with the vital statistics in this country must know that there is no city in this country of 100,000 people in which the death-rate is not over 18 to the thousand. Saint Louis reports, constantly, 11 to 12 per thousand.

THE PRACTICABILITY OF MAKING RETURNS OF PARTICULAR CLASSES OF DISEASES.

Dr. HARRIS. It has been found practicable where there are large bodies of employed men under close observation—such as miners, railroad employés, &c.—to keep such a record of the sickness and casualties as has really added to our stock of knowledge, and, inasmuch as in this country our great railway systems and certain great mining interests and various departments of employment do now keep these large bodies in such form, in such condition, as to admit of pretty exact records, the subject has seemed to be important and has received some study. Then our police force affords another field in which to make a series of studies. Recently the railway service of all the great trunk lines of German railways have come under study, and the results have been published to considerable extent and are valuable.

These returns show that it is entirely practicable to get at the history of the sickness and mortality in large bodies of men. When we come to communities the difficulties must be great; but I should think the subject would be of such importance as to justify its agitation from time to time. Dr. Snow may have some information on this subject, relating to manufacturing interests.

Dr. SNOW. I have no statistics or facts of any kind relating to it with any exactness. It is an important subject and one which seems to have some difficulty in it. I believe no collection of morbility statistics has ever been made to any extent in this country—no compulsory registration of infectious diseases.

Our Board of Health makes a direct requirement of the physician to make these returns. I tried to put in the word "householder," but some of our officials in the Board of Health knew more about it than I did and they struck out all but physicians. The success has been greater than I expected. I get from 35 to 60 reports a week of cases of zymotic diseases.

We have considerable diphtheria, and lately an increasing number of cases of measles. We get a very much better report than I expected, but I know we do not get all. I know twelve physicians that refused to report, but generally they do report their cases to me. I issued a postal-card upon which to make these reports, and also prepared some blanks for more full reports. They have given me a great deal of information. I learned a great deal of certain districts of the city that I did not know before, and thought it very important and encouraging.

Dr. TURNER. Since 1863 I have kept the morbility statistics in regard to the Navy. I have kept them through all the various stations, but have not yet got enough facts upon which to base any conclusions.

Dr. BILLINGS. In the Irish census for the last three decenniads an attempt has been made to register the cases of sickness on the day in the year in which the census was taken, registering all who are sick, whether in hospitals, infirmaries, or in their own homes, and taking the names of diseases as given by the persons themselves or the head of the household, the name often being given in Irish, and the matter worked out at the central registration office. An attempt of a similar nature will be made in the next United States census on the day of the visit of the enumerator. It was thought better to take that on the day of the visit of the enumerator than on a fixed day, as on the 1st of June. Our census will run over a period of two weeks. The chances for error for those places visited in the second week by the enumerator through its supervisor were too great to consider to make it worth while to carry out that system at the beginning. While we will not get the actual amount of sickness throughout the United States, we shall get a fair average view of the amount of morbility and disability at that season of the year, the first fortnight in June. I think the results will be of value to show what proportion of the people of the United States is sick or disabled at that season of the year. The name of the disease will be given, and the schedules prepared for the collection of these statistics will be submitted, as far as possible, to physicians. This will not be possible in large cities, but will be in many of the rural districts.

Dr. DURGIN. Until there is a complete registration of all diseases, our study of the relations existing between the meteorological observations and disease will be very imperfect indeed, but it has always seemed to me that the full registration of diseases would be an impossibility. I cannot conceive of our bringing about such a result. There are many people, many diseases that we can never hear from, people will not report them. In Boston we call for a very few of the zymotic diseases, and as soon as a report is received an inspector is sent to the premises to discover what local cause may be operating, and I assure you it furnishes a great field of labor.

I would like to ask Dr. Snow to what extent he calls for zymotic diseases?

Dr. SNOW. We call for all zymotic diseases, but we do not get them all. It would not do to generalize what we do get. We have scarlatina for instance. I have not the figures, but have been watching it with interest, the mortality decreasing as the epidemic passed away. So with diphtheria; we have had a great many cases of diphtheria reported, but it has not been epidemic at all, the mortality has been small. I have no doubt that when it was epidemic the mortality would not have been more than five. That fact looks as though it would be of interest.

Dr. Durgin. The calling for reports of cases, of scarlet fever in particular, has appeared to have good result in reducing the amount of disease. The Board of Health of Boston did not pass any stringent orders relative to scarlet fever, but simply took measures to keep those affected out of the schools. The average number of deaths per year from scarlet fever for the ten years prior to the establishment of the Board of Health, was 300; for the next three years following the average was 100; and I would also state that for those ten years the variations were not very great from year to year. Whenever a report of a case of scarlet fever or diphtheria is received, instructions have been sent to the household.

Dr. Snow. I think it is due to another cause—the presence of an epidemic. The mortality has been from 14 in a year to 290, and there has been a regular rise and fall. About once in five years it reaches its height. I have been able to tell months beforehand when we were going to have a large mortality from scarlet fever, and when we were going to be free from it. In another winter we will not have one-tenth of the deaths from this disease as we have had. The material is exhausted.

Dr. Cleemann. We report in the same way all these diseases except measles. The physician is not obliged to report measles. All of those diseases have been overlooked. Lately attention has been given to the report of cases of diphtheria. I agree with Dr. Snow, and think that I am able to forecast a decrease of scarlet fever in Philadelphia. I did venture to say that we will not this year have as much scarlet fever as we have had in the past.

Dr. Bemiss. I would inquire if Philadelphia has not had a very peculiar record with regard to scarlet fever. Did it not rise at one time to be a very fearful cause of death?

Dr. Cleemann. If you go back thirty or forty years, you will find we had more then than we have now; but whether that is due to the fact that it is only since 1861 that any case of diphtheria has been reported. I do not know.

Dr. Harris. The practical difficulty in getting these returns consists largely in adapting the sanitary service to the real interest of the families and to the pleasure and feelings of the physician as well as the families. When the first effort was made the difficulties were very great, objections were numerous; but the medical profession, I think, are quite in accord with the Board of Health as to the estimation of importance of the work, and if the questions could well be settled, "What is the duty of the local sanitary authority in cases so reported?" "How shall the sanitary authority adapt itself to its duty and to the profession and to the families?" I think nearly a complete registration could be secured. Dr. Snow is now working out a problem in his city, the solution of which I shall await with great interest. In New York I have seen what the difficulties are. The very first one is in getting the return in at the cost of the person making it. It has been a benefit to the community, and if certain difficulties could be provided against in the sanitary service, if there could be a little more of that clear understanding as to what the medical profession will gladly accept and what the sanitary authorities must do, good results would come. If the sanitary authority can first confer with the physician all will go pretty well. The physician who reports is a very responsible party in any transaction under the report, and this has grown in importance until New York is experiencing very beneficial results which will continue, I am sure, to become greater and greater as the sanitary service becomes more and more perfect.

Dr. Cleemann. In regard to the best way for sending in these card returns, I would state that in Philadelphia we furnish every physician with a number of these blanks and envelopes printed by direction of the Health Officer, and all the physician has to do is to drop them in a lamp-post, an arrangement being made with the postmaster for their collection.

The President. I will now announce the Committee on Nomenclature, Drs. Billings, Turner, Bailhache, Snow, and Folsom.

Dr. Billings. Yesterday morning when that committee was appointed the question was asked to whom they should report, and it has not been answered.

Dr. Snow. I was going to make a motion that this committee report to the National Board of Health. We must either do that or have the Board call another convention. I would therefore move that the committee appointed to confer with the Revision Committee of the Royal College of Physicians on the subject of nomenclature be ordered to report to the National Board of Health.

The motion was carried.

Dr. Harris. Is it desirable that this body should indicate any purpose or necessity for a subsequent conference or meeting, or can such a meeting be called by the National Board of Health? My own feeling in the matter is that it would be wise not to indicate any purpose or desire on the subject, because we cannot foresee the future far enough to be sure that it would be a wise movement; but such views were expressed by certain persons yesterday.

Dr. Durgin. It seems to me that it would be well to leave that to the National Board of Health, who might see the necessity of calling another convention after considering what has already been done.

NOMENCLATURE OF DISEASES OF THE EYE AND EAR.

Dr. Swan M. Burnett read a paper on Names for Diseases of Eye and Ear. (See Appendix B.)

On motion of Dr. Billings, the report was accepted and referred to the special committee to be appointed on nomenclature.

Dr. Billings presented a paper by John Tatham, M. D., health officer of Salford, England, on certain reforms which appear desirable in the statistical tables adopted in Annual Reports of Health Officers. The paper was accepted with thanks, and will be found in Appendix C.

The President. Before adjournment I take occasion on behalf of the National Board of Health to return its cordial thanks to the gentlemen present who came here at their own inconvenience and expense from different parts of the country to assist the National Board of Health in its efforts to secure uniformity in registration and other points connected with it, and to offer a pledge on behalf of the National Board that they will use their best efforts to carry out their views and wishes as expressed at this meeting. I wish you a happy and pleasant return to your homes.

The convention then adjourned.

Certificates of death.

State	city, or town.	Full name of deceased.	Age.	Color.	Sex.	Single, married, widow, or widower.	Occupation.	Birthplace.	How long resident in city.	If foreigner, how long in Un'd States.	Mother's birthplace.	Father's birthplace.	Place of death	Certif. of phys'n as to cause of death.	Time of attendance. From — to —.	Date of death.	Place of burial.	Date of burial.	Names of parents.	Disease or cause of death.	Duration of last illness.	Was there an autopsy?	Residence.	Condition, temperate.	Name of attendant.	Name and place of undertaker.	Date of certificate.	When last seen.	Remarks.	Sanitary surroundings.	Place where contracted.	Date of last visit.	Pauper Yes or no.	Previous residence.	Name of disease.	Complications of disease.	Duration of complications of disease.	Duration of medical treatment.	Duration of last medical treatment.	Name of wife or husband.	Date of birth.	Exact locality of death.	Residence of parents.	Maiden name, if married or widow.	If tenement, how many families.	If widow or wife, of whom.	Nationality.	How long resident in State.	Mother's maiden name.	Name of husband.	Duration of primary cause.	Duration of secondary cause.	On what floor.	Tenement or private residence.	Time at present residence.	Immediate cause of death	Citizen or stranger.	Name of informant.	Relation of informant.	Present and former occupation.	Occupation of wife or husband.	Occupation of parents.	Names, occupations, age, and residence of informants.	Ages of parents.
Ala	Mobile																																																															
Cal	San Francisco																																																															
	Los Angeles																																																															
	Vallejo																																																															
Colo	Boulder																																																															
Conn	New Haven																																																															
Del	Wilmington																																																															
Fla	Jacksonville																																																															
Ga	Augusta																																																															
Ill	Chicago																																																															
Ind	Evansville																																																															
	Richmond																																																															
Iowa	Burlington																																																															
Ky	Louisville																																																															
La	New Orleans																																																															
	Shreveport																																																															
Me	Portland																																																															
Md	Baltimore																																																															
Mass	State of																																																															
	Boston																																																															
Mich	Detroit																																																															
	Kalamazoo																																																															
Minn	Saint Paul																																																															
Miss	Vicksburg																																																															
Mo	Saint Louis																																																															
	Sedalia																																																															
Neb	Omaha																																																															
N. H	Concord																																																															
N. J	State of																																																															
N. Y	Brooklyn																																																															
	Buffalo																																																															
	Newburgh																																																															
	New York																																																															
	Rochester																																																															
	Seneca Falls																																																															
	Utica																																																															
	Yonkers																																																															
	Elmira																																																															
	Poughkeepsie																																																															
N. C	Wilmington																																																															
Ohio	Cincinnati																																																															
	Dayton																																																															
Penn	Erie																																																															
	Philadelphia																																																															
	Pittsburgh																																																															
	Reading																																																															
R. I	Providence																																																															
S. C	Charleston																																																															
Tenn	Chattanooga																																																															
	Clarksville																																																															
	Memphis																																																															
	Nashville																																																															
	Shelbyville																																																															
Tex	Austin																																																															
	Brownsville																																																															
	Galveston																																																															
Vt	Burlington																																																															
Va	Norfolk																																																															
	Richmond																																																															
Wis	Milwaukee																																																															
D. of C	Washington																																																															
G. B	England																																																															
Belgium	Brussels																																																															

TABLE SHOWING INFORMATION CALLED FOR ON RETURNS OF DEATHS, BIRTHS, AND MARRIAGES, &C.—Continued.

Certificates of births.

State, city, or town.		Full name of child.	Sex.	Race or color.	Date of birth.	Place of birth.	Number of child of mother.	Full name of mother.	Mother's residence.	Full name of father.	Father's occupation.	Father's birth place.	Age of father.	Age of mother.	Weight of child at birth.	Duration of labor.	Father's residence.	Color of father.	Color of mother.	Number of child.	Number of children now living.	Illegitimate or twin.
Ala	Mobile			+	+	+		+		+	+	+										
Cal	Los Angeles			+	+				+	+	+	+					+					
	San Francisco			+	+			+	+	+	+	+					+					
	Vallejo	+	+	+	+				+	+	+						+					
Colo	Boulder		+	+	+	+			+	+												
Conn	State of		+		+	+				+	+	+	+	+			+	+	+	+	+	+
Ill	Chicago		+	+	+	+	+	+	+	+	+	+	+	+								
	Galesburg		+		+	+		+		+	+	+										
Iowa	Burlington	+	+	+	+	+						+										
La	New Orleans	+	+	+	+	+			+	+	+	+	+	+		+						
	Shreveport	+	+	+	+	+		+	+	+	+	+	+	+			+					
Md	Baltimore		+	+	+	+	+	+		+	+	+										
Mass	State of	+	+	+	+	+	+	+	+	+	+	+					+					+
Minn	Saint Paul			+	+	+		+		+	+	+										
Miss	Vicksburg		+	+	+					+		+										
Mo	Saint Louis	+		+	+	+		+		+		+										
	Sedalia		+	+	+			+	+	+							+					
Nebr	Omaha	+	+	+	+	+		+		+												
N. H	Concord	+		+	+			+	+	+	+	+					+					
N. J	State of	+		+	+	+	+			+		+										
N. Y	Brooklyn			+	+	+	+	+	+	+	+	+	+	+								
	Buffalo		+	+	+	+		+		+												
	Newburg				+			+	+	+		+										
	New York	+		+	+	+	+	+	+	+	+	+	+	+	+	+						
	Elmira			+	+	+	+	+	+	+	+	+	+	+	+	+						
	Yonkers		+	+	+	+	+	+	+	+	+	+	+	+								
Ohio	Cincinnati	+	+	+	+			+	+	+	+	+					+					
	Cleveland																					
	Dayton	+	+		+	+					+	+										
Pa	Philadelphia	+	+		+	+		+		+	+	+										
	Pittsburgh		+		+			+		+	+											
	Reading	+	+		+	+		+		+	+											
R. I	State of	+			+	+	+	+		+	+	+	+	+				+	+			
S. C	Charleston	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+						
Tenn	Memphis	+	+	+	+	+	+	+		+												
Tex	Galveston	+	+	+	+			+		+												
Vt	Burlington		+	+	+	+		+	+		+	+	+	+								
Wis	Milwaukee																					
D. C	Washington																					
Belgium	Brussels																					

State, city, or town.		Condition of mother.	Condition of child.	If still-birth, the cause.	Name and address of medical or other attendant.	Nationality of father.	Nationality of mother.	Part presenting.	Legitimate? Yes or no.	Occupation of mother.	Names of other issue living.	Mother's maiden name.	Mother's birth place.	Remarks.	Natural or otherwise.	Any unusual mark.	Hour of birth.	Name and address of person making return.	Date of return.	Period of gestation.	Name of informant.	Name, occupation, age, and residence of two persons present.
Ala	Mobile							+					+	+								
Cal	Los Angeles				+								+	+								
	San Francisco		+		+	+	+					+	+									
	Vallejo				+							+	+									
Colo	Boulder		+									+		+								
Conn	State of								+			+	+	+								
Ill	Chicago				+	+	+					+	+	+								
	Galesburg									+			+	+								
Iowa	Burlington											+	+	+								
La	New Orleans									+		+	+	+								
	Shreveport									+		+	+									
Md	Baltimore				+							+	+	+								
Mass	State of											+	+									
Minn	Saint Paul												+									
Miss	Vicksburg		+									+	+									
Mo	Saint Louis																					
	Sedalia														+	+						
Nebr	Omaha																					
N. H	Concord	+											+									
N. J	State of				+							+	+									
N. Y	Brooklyn				+							+	+				+	+				
	Buffalo					+	+															
	Newburg				+								+					+				
	New York				+							+	+					+	+			
	Elmira				+			+				+	+					+	+			
	Yonkers				+							+	+					+	+			
Ohio	Cincinnati												+	+								
	Cleveland																					
	Dayton											+	+	+								
Pa	Philadelphia																					
	Pittsburgh																	+	+			
	Reading																					
R. I	State of											+	+	+								
S. C	Charleston				+							+	+					+	+			
Tenn	Memphis					+	+															
Tex	Galveston		+																	+		
Vt	Burlington											+										
Wis	Milwaukee										+	+	+	+			+					
D. C	Washington											+						+				
Belgium	Brussels																+				+	+

Returns of marriages.

State, city, or town.		Full name of groom.	Residence.	Age.	Race or color.	Occupation.	Place of birth.	Father's name.	Mother's maiden name.	Number of groom's marriage.	Full name of bride.	Maiden name, if widow.	Residence.	Age.	Race or color.	Place of birth.
Colo	Boulder		+			+					+		+		+	+
Conn	State of			+								+	+	+	+	+
Ill	Chicago	+	+	+						+	+	+	+	+	+	+
La	Shreveport										+					
Me	Portland	+	+								+		+			
Mass	State of	+	+	+	+						+	+	+	+	+	+
	Boston	+	+	+				+		+	+	+	+	+	+	+
Minn	Saint Paul	+	+	+							+		+	+		
N. H	Concord	+	+	+				+		+	+		+	+	+	+
N. J	State of		+	+		+	+		+	+	+	+	+			+
N. Y	Brooklyn	+	+	+		+		+	+	+	+	+	+	+		+
	Buffalo	+	+	+							+		+	+		
	New York	+	+	+	+		+		+	+	+	+	+	+	+	
	Elmira	+	+	+			+				+	+	+	+	+	+
	Newburg		+	+			+	+			+	+	+	+	+	+
	Utica		+	+							+		+	+		+
	Yonkers										+					
Pa	Philadelphia		+	+							+		+	+	+	+
	Pittsburgh	+	+	+							+		+	+	+	+
	Reading	+	+	+							+		+	+	+	+
S. C	Charleston	+	+	+	+	+					+	+	+	+	+	+
Tenn	Clarksville	+									+					
	Memphis	+	+	+	+		+			+		+	+	+	+	+
Vt	Burlington	+	+	+				+	+	+	+	+	+	+		+
District of Columbia		+	+		+	+	+			+	+		+		+	+

State, city, or town.		Father's name.	Mother's maiden name.	Number of bride's marriage.	By whom married.	By whom affidavit, if any, is made.	By whom consent to marriage given.	Where married.	Dat of marriage.	Conj gal condition.	Occupation of bride.	Nationality of parents.	Witnesses' name and residence.	Birthplace of parents.	Occupation of bride's father.	Ceremony employed.	Date of certificate.
Colo	Boulder							+	+	+	+						
Conn	State of								+	+		+					
Ill	Chicago	+	+	+	+			+	+				+				
La	Shreveport								+				+				
Me	Portland				+			+	+								
Mass	State of	+	+	+				+	+								
	Boston	+	+	+	+			+	+								
Minn	Saint Paul								+	+							
N. H	Concord	+		+				+	+					+	+		
N. J	State of	+	+	+	+			+	+				+	+			
N. Y	Brooklyn	+	+	+									+				
	Buffalo								+				+				
	New York	+	+	+					+				+				
	Elmira	+	+	+					+				+				
	Newburg	+	+	+					+				+				
	Utica																
	Yonkers							+	+				+				
Pa	Philadelphia								+								
	Pittsburgh				+			+	+							+	
	Reading								+								
S. C	Charleston				+			+	+				+				
Tenn	Clarksville								+								
	Memphis			+	+				+								
Vt	Burlington	+	+	+	+			+	+								
District of Columbia				+	+				+								

APPENDIX B.

A NOMENCLATURE OF OPHTHALMOLOGY AND OTOLOGY.

[By Dr. SWAN M. BURNETT, Washington, D. C.]

In making a nomenclature of ophthalmology and otology to be used by English-speaking people and by non-specialists as well as specialists, it is often a matter of difficulty to select the proper term for certain affections.

For a universal nomenclature the Latin terms would, of course, be by far the most desirable, since this is the universal language of science; but to employ it in this instance altogether would, we fear, defeat the object we have in view. We have, therefore, always employed, wherever practicable, the English words, only taking the Latin or Greek where the terms used are so common and well understood as to be properly considered as anglicized, or where they offered the advantage of decided brevity and compactness.

As far as possible we have tried to make the specific name of the disease correspond to the known or supposed pathology of the affection, though, in deference to past usages, we have in some cases at the same time given the name furnished by other characteristics. Thus: We have given, in addition to *Conjunctivitis, purulent, C. gonorrheal*, to indicate its special cause, and *C. of the new born*, because this has for years been spoken of as a specific form of purulent conjunctivitis. Of course it has not been possible to give every name a disease has been or is even now known by, but we think that it is possible to properly classify any affection of the eye or ear under some name to be found in the following nomenclature.

JUNE 18, 1880.

AFFECTIONS OF THE CHOROID AND VITREOUS HUMOR.

Choroiditis, areolar.
Choroiditis, exudative.
Choroiditis, disseminate.
Choroiditis, metastatic.
Choroiditis, plastic.
Choroiditis, purulent.
Choroiditis, serous.
Choroiditis, spongy (gelatinous).
Choroiditis, syphilitic.
Chorio-retinitis.
Coloboma of the choroid.
Colloid degeneration of the choroid.
Detachment of the choroid.
Formation of bone in the choroid.
Foreign bodies in the vitreous humor.
Hemorrhage into the choroid.
Hyperaemia of the choroid.
Inflammation of the vitreous humor (hyalitis).
Opacities of the vitreous.
Persistent hyaloid artery.
Rupture of the choroid.
Tubercles in the choroid.
Tumors of the choroid.
Sclerotico-choroiditis.
Synchesis of the vitreous humor.

AFFECTIONS OF THE CONJUNCTIVA.

Apoplexy of the conjunctiva (ecchymosis).
Burns of the conjunctiva.
Chemosis.
Conjunctivitis, catarrhal.
Conjunctivitis, croupous.
Conjunctivitis, diphtheritic.
Conjunctivitis, follicular.
Conjunctivitis of the globe.
Conjunctivitis of the lids.
Conjunctivitis of the new-born.
Conjunctivitis, phlyctenular.
Conjunctivitis, purulent.
Conjunctivitis, pustular.
Conjunctivitis, trachomatous.
Emphysema of the conjunctiva.
Encanthis.
Hyperæmia of the conjunctiva.
Lithiasis of the conjunctiva.
Metallic stains.
Parasites in the conjunctiva.
Perikeratitic hypertrophy of the conjunctiva.
Pinguecula.
Pterygium.
Trachoma.
Tumors of the conjunctiva.
Ulcer of the conjunctiva.
Wounds of the conjunctiva.
Xerosis of the conjunctiva.

AFFECTIONS OF THE CORNEA.

Abscess of the cornea.
Abrasion of the cornea.
Fistula of the cornea.
Foreign bodies in the cornea.
Hernia of the cornea.
Hydrophthalmus.
Hypopyon.
Keratitis, diffuse.
Keratitis, bullosa.
Keratitis, fascicular.
Keratitis, neuro-paralytic.
Keratitis, pannous.
Keratitis, parenchymatous (interstitial).
Keratitis, phlyctenular.
Keratitis, punctate (pyramidal.)
Keratitis, purulent.
Keratitis, traumatic.
Keratitis, vesicular. (Herpes.)
Kerato-conus.
Kerato-globus.
Kerato-iritis.
Kerato-malacia.
Leucoma-adherens.
Leucoma of the cornea.
Macula of the cornea.
Onyx.
Pannus, crassus.
Pannus, tenuis.
Resorption ulcer of the cornea.
Sclerosis of the cornea.
Serpent ulcer of the cornea.
Sloughing of the cornea.
Staphyloma of the cornea.
Tumor of the cornea.
Ulcer of the cornea.
Wounds of the cornea.

GLAUCOMA.

Glaucoma, acute.
Glaucoma, absolute.
Glaucoma, chronic.
Glaucoma, fulminans.
Glaucoma, hemorrhagic.
Glaucoma, imminent.
Glaucoma, inflammatory.
Glaucoma, secondary.
Glaucoma, simple.
Glaucoma, sympathetic.
Glaucomatous degeneration.
Essential phthisis bulbi.

AFFECTIONS OF THE IRIS AND CILIARY BODY.

Corectopia.
Cyclitis, plastic.
Cyclitis, purulent.
Cyclitis, serous.
Cyclitis, sympathetic.
Exclusion of the pupil.
Foreign bodies in the iris.
Gumma of the iris.
Hernia of the iris.
Hypophæma.
Irido-choroiditis, plastic.
Irido-choroiditis, purulent.
Irido-choroiditis, spongy (gelatinous).
Irido-choroiditis, serous.
Irido-cyclitis plastic.
Irido-cyclitis purulent.
Irido-cyclitis serous.
Irido-cyclitis sympathetic.
Iritis, arthritic.
Iritis, gonorrheal.
Iritis, plastic.
Iritis, purulent.
Iritis, rheumatic.
Iritis, serous.
Iritis, spongy (gelatinous).
Iritis, sympathetic.
Iritis, syphilitic.
Iritis, traumatic.
Iritis, tuberculous.
Iridiremia.
Mydriasis.
Myosis.
Occlusion of the pupil.
Reversion of the iris.
Rudimentary iris.
Rupture of the iris.
Synechia anterior.
Synechia posterior.

Tremulous iris.
Tumors of the iris.
Wounds of the iris.

AFFECTIONS OF THE LACHRYMAL APPARATUS.

Atresia of the puncta.
Dacryo-adenitis.
Dacryo-cystitis, catarrhal.
Dacryo-cystitis, purulent.
Double punctum.
Dacryo-lithiasis.
Eversion of the puncta.
Exostosis of the nasal duct.
Fistula of the lachrymal sac.
Foreign bodies in the punctum.
Polypus of the lachrymal sac.
Stillicidium lachrymarium (Epiphora).
Stricture of the nasal duct.

AFFECTIONS OF THE LENS.

Aphakia.
Cataract, accreted.
Cataract, anterior polar (pyramidal).
Cataract, axial.
Cataract, black.
Cataract, calcareous.
Cataract, capsular.
Cataract, complete.
Cataract, congenital.
Cataract, cortical.
Cataract, diabetic.
Cataract, fusiform (spindle-shaped).
Cataract, hard.
Cataract, hypermature.
Cataract, incipient.
Cataract, incomplete.
Cataract, lamellar (zonular).
Cataract, membranous.
Cataract, morgagnian.
Cataract, nuclear.
Cataract, posterior polar.
Cataract, punctate.
Cataract, secondary.
Cataract, senile.
Cataract, soft.
Cataract, spurious.
Cataract, traumatic.
Coloboma lentis.
Dislocation of the lens.
Phakitis.
Lenticonus.
Subluxation of the lens.

AFFECTIONS OF THE LIDS.

Ablepharon.
Abscess of the lids.
Acarus folliculorum.
Acne moluscum.
Ankyloblepharon.
Anthrax of the lids.
Blepharitis marginalis.
Blepharo adenitis.
Blepharo spasm.
Blepharo phymisis.
Chalazion.
Chromhydrosis (Blepharal melasma).
Coloboma palpebrarum.
Distichiasis.
Ectropion.
Elephantiasis palpebrarum.
Emphysema.
Entropion.
Epicanthus.
Erythema of the lids.
Hæmophthalmus externus.
Hæmatidrosis.
Herpes of the lids.
Hordeolum.
Hyperæmia of the lids.
Hyperidrosis.
Infiltration of the lids.
Lagophthalmus.
Nictitation.
Paralysis of the orbicularis.
Phthiriasis ciliarum.
Ptosis atonic.
Ptosis congenital.
Ptosis paralytic.
Seborrhœa.
Tarsitis.
Trichiasis.
Tumors of the lid.
Verruca of the lids.
Xanthelasma of the lids.

AFFECTIONS OF THE MUSCLES OF THE EYE.

Blepharo spasm.
Enopthalmus, spastic.
Insufficiency of the internal rectus.
Insufficiency of the external rectus.
Laceration of the ocular muscles.
Nystagmus, atonic.
Nystagmus, oscillating.
Nystagmus, rotating.
Nystagmus, tonic.
Ophthalmoplegia externa (paralysis of all the external muscles of the eye).
Ophthalmoplegia interna (paralysis of all the internal muscles of the eye).
Paralysis of the ciliary muscle (cycloplegia).
Paralysis of the external rectus muscle.
Paralysis of the inferior rectus muscle.
Paralysis of the internal rectus muscle.
Paralysis of the inferior oblique muscle.
Paralysis of the levator palpebræ.
Paralysis of the motor oculi communis.
Paralysis of the obicularis.
Paralysis of the superior oblique.
Paralysis of the superior sectus.
Spasm of the ciliary muscle.
Strabismus, bilateral.
Strabismus, concomitant.
Strabismus, convergent.
Strabismus, divergent.
Strabismus, downward.
Strabismus, monolateral.
Strabismus, paralytic.
Strabismus, upward.

AFFECTIONS OF THE ORBIT AND GLOBE.

Abscess of the orbit.
Argyria oculi.
Caries of the orbit.
Cellulitis of the orbit.
Dislocation of the eyeball.
Effusion of blood in the orbit.
Emphysema of the orbit.
Fracture of the orbital bones.
Inflammation of the frontal sinus.
Necrosis of the orbital bones.
Periostitis of the orbit.
Panophthalmitis.
Tenonitis.
Tumor of the orbit.

ANOMALIES OF REFRACTION, ACCOMMODATION, AND VISION.

Achromatopsia.
Amaurosis.
Amaurosis, hysterical.
Amaurosis, partial, transient.
Amaurosis, without ophthalmoscopic signs.
Amblyopia, alcoholic.
Amblyopia, congenital.
Amblyopia, central.
Amblyopia, saturnine.
Amblyopia, tobacco.
Amblyopia, toxic.
Amblyopiae anopsia, (from non-use).
Amblyopia, hysterical.
Anisometropia.
Asthenopia, accommodative.
Asthenopia, muscular.
Asthenopia, retinal.
Astigmatism, compound (myopic or hypermetropic).
Astigmatism, irregular.
Astigmatism, mixed.
Astigmatism, regular.
Astigmatism, simple (myopic or hypermetropic).
Blue-yellow blindness (*Hering*).
Chromatopsia.
Dyschromatopsia, (feeble color-sense).
Flittering scotoma.
Green blindness.
Hemeralopia.
Hemianopsia, inferior.
Hemianopsia, left.
Hemianopsia, right.
Hemianopsia, superior.

Hypermetropia, axial.
Hypermetropia, from deficient curvature of the refracting surfaces.
Hypermetropia, acquired.
Hypermetropia, latent.
Macropsia.
Metamorphopsia.
Micropsia.
Muscae volitantes.
Myopia, axial.
Myopia, acquired.
Myopia, from excessive curvature of the refracting surfaces.
Myopia, false.
Nyctalopia.
Photopsia.
Polyopia, monocular.
Red-blindness.
Red-green blindness (*Hering*).
Scotoma.
Snow-blindness.
Violet-blindness.

AFFECTIONS OF THE RETINA AND OPTIC NERVE.

Amaurotic cat's-eye.
Apoplexy of the retina.
Atrophy of the optic nerve.
Atrophy of the optic nerve, progressive.
Chorio-retinitis, diffuse.
Chorio-retinitis, disseminated.
Chorio-retinitis, circumscribed.
Commotio retinæ.
Cystic degeneration of the retina.
Detachment of the retina.
Dropsy of the optic nerve sheath.
Epilepsy of the retina.
Embolism of the central artery of the retina.
Embolism of a branch of the central artery of the retina.
Effusion under the retina.
Excavation of the optic disk.
Foreign bodies in the retina.
Hyperæmia of the retina.
Ischæmia of the retina.
Neuro-retinitis.
Neuro-retinitis, ascending.
Neuro-retinitis, descending.
Neuritis, syphilitic.
Œdema of the retina.
Opaque optic nerve fibres.
Papillitis, (choked disk).
Peripapillary degeneration of the retina.
Perineuritis, optic.
Perivasculitis, retinal.
Retinitis, albumenuric.
Retinitis, central.
Retinitis, central recurring.
Retinitis, chronic.
Retinitis, circumpapillary.
Retinitis, circumscribed.
Retinitis, diabetic.
Retinitis, diffuse.
Retinitis, hemorrhagic.
Retinitis, leucæmic.
Retinitis, nyctalopic.
Retinitis, oxaluric.
Retinitis, pigmentary.
Retinitis, proliferating.
Retinitis, pernicious anemic.
Retinitis, sympathetic.
Retrobulbar optic neuritis.
Torpor of the retina.
Tumors of the retina.

AFFECTIONS OF THE SCLEROTIC.

Anterior scleral staphyloma.
Episcleritis.
Foreign bodies in the sclera.
Posterior scleral staphyloma.
Scleritis.
Wounds of the sclera.

AFFECTIONS OF THE EXTERNAL EAR.

Congelation of the auricle.
Eczema of the auricle.
External auditory canal, atresia of.
External auditory canal, circumscribed inflammation of.
External auditory canal, condylomata in.
External auditory canal, diffuse inflammation of.
External auditory canal, exostosis of.
External auditory canal, foreign bodies in.
External auditory canal, hyperostosis of.
External auditory canal, polypus in.
External auditory canal, pruritus of.
External auditory canal, ulceration of.
External auditory canal, vegetable fungous growths in.
Inspissated cerumen.
Inflammation of the auricle.
Malformations of the auricle.
Perichondritis.
Tumors of the auricle.
Wounds of the auricle.

AFFECTIONS OF THE MIDDLE EAR AND MEMBRANA TYMPANI.

Anchylosis of the ossicles.
Caries of the temporal bone.
Exfoliation of the temporal bone.
Fracture of the malleus handle.
Membrana tympani, acute inflammation of.
Membrana tympani, adhesion of, to the promontory.
Membrana tympani, calcareous deposits in.
Membrana tympani, chronic inflammation of.
Membrana tympani, destruction of.
Membrana tympani, ecchymosis of.
Membrana tympani, formation of bone in.
Membrana tympani, injuries to.
Membrana tympani, perforation of.
Membrana tympani, rupture of.
Mastoid cells, catarrhal inflammation of (primary).
Mastoid cells, catarrhal inflammation of (secondary).
Mastoid cells, periostitis of (primary).
Mastoid cells, periostitis of (secondary).
Mastoid cells, suppurative inflammation of (primary).
Mastoid cells, suppurative inflammation of (secondary).
Middle ear, acute catarrhal inflammation of.
Middle ear, acute suppurative inflammation of.
Middle ear, caries and necrosis of the walls of.
Middle ear, chronic catarrhal inflammation of.
Middle ear, chronic suppurative inflammation of.
Middle ear, exostosis of.
Middle ear, hemorrhage into.
Middle ear, hyperostosis of.
Middle ear, polypus in.
Middle ear, proliferous inflammation of.
Middle ear, tumors in.
Necrosis of the temporal bone.
Myringomycosis.
Otalgia.

AFFECTIONS OF THE INNER EAR.

Boiler-maker's deafness.
Deafmutism.
Deafness to certain tones.
Double hearing with both ears.
Inflammation of the labyrinth, primary.
Inflammation of the labyrinth, secondary.
Ménières complex of symptoms.
Nervous deafness.
Restricted range of audition.
Tinnitus aurium.

OPERATIONS ON THE EYE.

On the conjunctiva.

For pterygium.
Removal of tumors.
Removal of foreign bodies.
Syndectomy (peritomy).

On the cornea and anterior chamber.

Ablation of staphyloma.
For serpent ulcer of the cornea (*Sämisch*).
Paracentesis of the cornea.
Removal of foreign bodies from the cornea.
Removal of tumors from the cornea.
Removal of foreign bodies from the anterior chamber.
Tattooing of the cornea.

On the globe and orbit.

Enucleation of the globe.
Exenteratio orbitæ.
Extraction of foreign bodies from the interior of the eye.
Neurectomy.
Optico-ciliary neurotomy.
Paracentesis of the walls of the globe.
Puncture of the optic-nerve sheath.
Removal of tumors from the orbit.
Removal of tumors from the optic nerve.
Sclerotomy.

On the lids.

For ankyloblepharon.
Blepharoplasty.

For destruction of the hair follicles.
For ectropion.
For entropion.
For enlargement of the palpebral opening.
For evacuation of cysts.
For excision of piece of tarsal cartilage.
For ptosis.
For removal of tumors.
For removal of hair bulbs.
For removal of the tarsal cartilage.
For the restoration of lid.
For symblepharon.
For tarsorrhaphy (diminishing of the palpebral opening).
For trichiasis.
Transplantation of the cilia.

On the muscles.

Tenotomy of the muscles (strabotomy).
Advancement of a muscle.
Excision of a piece of a muscle.

On the iris.

Corelysis (Streatfield.)
Detachment of posterior synechia (*Passavant*).
Iridectomy.
Iritomy.
Irito-ectomy.
Indodesis.
Removal of foreign bodies from the iris.

On the lachrymal apparatus.

Destruction of the lachrymal sac.
Division of stricture of the nasal duct.
Enlargement of the punctum.
Opening of the lachrymal sac.
Probing the nasal duct.
Removal of the lachrymal gland.
Slitting up the canaliculus.

On the lens.

For depression of cataract (couching).
For extraction of cataract by the flap method.
For extraction of cataract by the Gräfe method.
For extraction of cataract in the capsule.
For extraction of cataract by the linear method.
For extraction of cataract by the Weber method.
For extraction of cataract by the sclero-corneal flap method.
For scoop extraction.
For secondary cataract.
For solution of cataract.
For removal of cataract by suction.

OPERATIONS ON THE EAR.

Catheterization of the eustachian tube.
Dilatation of the eustachian tube.
Division of the tensor tympani.
Excision of the malleus.
Insertion of artificial drum-head.
Myringo-plasty.
Paracentesis of membrana tympani.
Removal of granulations from external or middle ear.
Removal of foreign bodies from external or middle ear.
Removal of tumors from external or middle ear.
Removal of carious or necrosed bone.
Removal of tumors from the auricle.
Removal of polypi.
Trephining or puncturing the mastoid process.
Wilde's incision.

APPENDIX C

ON STATISTICAL TABLES FOR LARGE URBAN DISTRICTS.

[By JOHN TATHAM, M. D., San. Cert., Cambridge: Medical Officer of Health, Salford, England.]

Concurrently with the advancement of public opinion on the subject of public health, and with the unprecedented activity which has been shown by the various sanitary authorities of the country of late years, one would have hoped that a corresponding improvement would have been effected in our national health records; it is notorious, however, that this has not been the case.

Many sanitarians, including myself, have long deplored the fact that, although the whole of England has been parceled out into sanitary districts, and a health officer has been appointed for each, yet the national collection of local sanitary statistics still remains comparatively so meager as to be discreditable to the public-health service.

I do not say that this is the fault of the health officers themselves. The present unsatisfactory condition of our national vital statistics is largely due to the fact that, with respect at least to the large urban districts, from which the most reliable and valuable statistics might have been expected, the health officers of these authorities are working solely with regard to local requirements, and entirely without reference to a national statistical system; and, although many of the medical officers of health attached to the large English towns are gentlemen of large experience, whose reports are of immense local value and bear evidence of conspicuous ability on the part of their authors. yet their annual reports, when considered as local contributions to a national system of vital statistics, are with comparatively few exceptions well-nigh worthless, solely from want of uniformity in the tabular forms employed.

I do not believe that I could now lay my hand upon a dozen out of the large number of health reports annually issued in England from which, without troublesome calculations, I could extract such rudimentary statistical information as would enable me to fill up the appended tables A, B, C, and D.

I desire to submit these remarks with all deference, and I trust that what I have to advance will be accepted as a humble endeavor on my part to further the science and facilitate the study of vital statistics in relation to public health.

I beg to remark, *in limine*, that inasmuch as it will be impossible to construct a set of tables which shall be available for all possible contingencies, I wish it to be distinctly understood that I by no means desire to limit my brethren to the use of these or any other statistical forms, but rather to suggest the following tables as a minimum only of statistical information, to the use of which, with whatever modifications may be deemed expedient, we can all agree, and I am confident that if this minimum standard can be secured in the annual health reports of the country, a uniform mass of statistical information respecting the various districts of the kingdom would be available for the use equally of the statist and the statesman, which in the interests of the public health would be of incalculable worth, whilst the element of uniformity would itself vastly increase even the local value of such information, by facilitating comparison between various populations similarly circumstanced.

The following is a short summary of the information given in the appended tables, and will explain the nature of the particulars to which each table has reference:

TABLE A

Gives the population of the borough estimated to the middle of each year, the density, the births, deaths, and the corresponding rates.

TABLE A[1]

Gives similar particulars for the various statistical divisions of the borough for the current year.

TABLE B.

This table gives an analysis of the mortality for a series of years. It shows the deaths of children at the ages under one year and under five years, and of persons over sixty years, and also the death-rates at those ages, and from seven zymotic diseases; the infantile mortality being measured by the number of children dying under twelve months old per one thousand births.

TABLE C

Gives the births registered in a town, and in its various registration subdistricts, wards, or other statistical subdivisions, distinguishing legitimate and illegitimate births. This table, when filled up, generally shows very forcibly how different is the rate of mortality of illegitimate children as compared with that of children born in wedlock.

TABLE D

Gives the estimated population, the births and birth-rate, the deaths and rate of mortality, per 1,000 living during 18— in the various statistical subdivisions of a town. The death-rates are also given for these areas from the five principal classes of disease; the deaths occurring in public institutions having been distributed.

NORMAL RATE TABLE.

In order to compile the above table, which is the key to the next table, E, it is necessary to know the proportion of persons living at the various-age groups, and the number of deaths that should occur at normal or life-table rates. It is very essential, however, that these data should be obtained, for a calculation of the deaths at a certain-age group on the population living at all ages is worthless, and, worse, it is misleading.

TABLE E

Gives the population and the annual rate of mortality occurring in a town at five groups of ages, compared with the English life-table rate at those ages, for persons, for males, and for females.

A glance at this table will show how essential it is to ascertain not only the number of persons living at the various-age groups, but also the life-table rates at those ages, in order that we may know how

much the death-rate at any given age group of a given locality may be in excess or in defect of the life-table rates at that age.

The grouping of ages here adopted has been used by the registrar-general in his weekly returns, under the advice of Dr. Farr, for more than forty years. And if it be admitted that, for local reports relating to populations not exceeding two or three hundred thousand at all ages, five groups of ages is sufficient subdivision, it seems impossible to adopt a more convenient grouping.

TABLE F.

The main object of this table is to show all the principal causes of death in combination with ages at the five selected groups, so arranged as to appear conveniently in a report on one page of ordinary dimensions, and thus to avoid the unwieldy folded tables commonly in vogue, and which are so troublesome to refer to and to use. If it is judged desirable to show the causes of death of males and females separately, three of these page tables should be given, one each for males, females, and persons; except, however, in special investigations this appears to be unnecessary.

TABLE G

Gives the deaths from several specified causes without distinction of age occurring in the various wards or other subdivisions of the borough, and also the deaths occurring in the various public institutions.

TABLE H

Gives the annual rate of mortality during the twelve months from the five classes of disease at five groups of ages per 1,000 persons estimated to be living at all ages. When filled up, this table shows how misleading is a statement of the general death-rate due to any important class of diseases when taken as an expression of their fatality at certain ages.

TABLE I

Gives the number of deaths and the proportion of deaths certified by medical practitioners, by the coroner, and the number and proportion of uncertified deaths. This table should never be omitted from a health report.

TABLE J

Gives the prices paid by the poor-law authority for the principal articles of food and fuel. These prices may be taken as approximately representing the minimum average prices paid by the public for similar commodities. The average weekly number is also given of paupers relieved by the guardians.

TABLE A.

Population, density, births, deaths, and annual death-rate in the borough of Salford for each of the ten years, 1870 to 1879.

Year.	Population in middle of each year.	Density—persons per acre.	Births.	Deaths.	Annual rate per 1,000 living.	
					Births.	Deaths.
1870........						
1871........						
1872........						
1873........						
1874........						
1875........						
1876........						
1877........						
1878........						
1879........						

TABLE A¹.

Area, population, density, and death-rates of the various wards of the borough, arranged in order of their increasing densities.

Wards.	Area.	Population.	Density—persons per acre.	Death-rate.
Seedley				
Kersal				
St. Thomas				
St. John				
Regent				
Crescent				
Islington				
Ordsal				
St. Stephen's				
Greengate				
St. Matthias				
Trinity				
Borough				

TABLE B.

Analysis of the mortality in the borough of Salford in each of the ten years 1870 to 1879.

Year.	Deaths of infants under 1 year.	Proportion of deaths under 1 year to 1,000 births.	Deaths.				Annual death-rate per 1,000 living.			
			From all causes.	Of children under 5 years.	Of persons aged 60 years and upwards.	From seven zymotic diseases.	All causes and all ages.	Children under 5 years.	Persons aged 60 years and upwards (all causes).	Seven zymotic diseases (all ages).
1870............										
1871............										
1872............										
1873............										
1874............										
1875............										
1876............										
1877............										
1878............										
1879............										

TABLE C.

Births in the borough of Salford and in its twelve wards during the year 1878, distinguishing legitimate and illegitimate births. Also the proportion of mortality among infants under one year of age.

Wards.	Births.		Percentage of illegitimate births to total births.	Deaths under 1 year.		Proportion of deaths under 1 year per 1,000 births.		
	Total.	Illegitimate.		Total.	Of illegitimate children.	Total.	Legitimate.	Illegitimate.
Total in borough............								
Trinity								
Islington								
Ordsal								
Regent								
Crescent								
St. Stephen's								
St. Matthias								
Greengate								
St. Thomas								
Seedley								
St. John's								
Kersal								

TABLE D.

Estimated population, births, birth-rate, deaths, and rate of mortality per 1,000, during 1879, in the borough of Salford and in each of its wards, from all causes and from each of the five principal classes of disease, after distribution of the deaths occurring in public institutions.

Statistical district.	Population estimated to the middle of the year 1879.	Births.		Deaths.		Death-rate per 1,000 living from—				
		Registered in 52 weeks of 1879.	Rate per 1,000 living.	Registered in 52 weeks of 1879.	Rate per 1,000 living.	Class I.—Zymotic diseases.	Class II.—Constitutional diseases.	Class III.—Local diseases.	Class IV.—Developmental diseases.	Class V.—Violence.
Borough.........										
Trinity										
Islington										
Ordsal										
Regent										
Crescent										
St. Stephen's										
St. Matthias										
Greengate										
St. Thomas										
Seedley										
St. John's										
Kersal										

NORMAL RATE TABLE.

Normal death-rate in Salford registration district, calculated on the English life-table standard, with due allowance for the sex and age proportion in the population.

Ages.	Males.		Females.		Deaths in 1,000 of the Salford population.		
	Annual rate of mortality per 1,000 according to the English life-table.	Salford proportion to 1,000 persons living, 1871.	Annual rate of mortality per 1,000 according to the English life-table.	Salford proportion to 1,000 persons living, 1871.	Males.	Females.	Persons.
Columns	1	2	3	4	5	6	7
All ages	25. 0534	474. 97	23. 8965	525. 03	10. 6305	10. 8688	21. 4993
0- 5	70. 1364	71. 23	61. 2549	70. 37	4. 9958	4. 3105	9. 3063
5-20	7. 0126	153. 62	7. 2009	159. 14	1. 0773	1. 1460	2. 2233
20-40	10. 1210	152. 67	10. 4821	177. 87	1. 5452	1. 8645	3. 4097
40-60	19. 4064	76. 89	17. 1884	88. 62	1. 4921	1. 5232	3. 0153
60 and upward	73. 9345	20. 56	69. 7419	29. 03	1. 5201	2. 0246	3. 5447

These numbers are obtained by casting the deaths at each group of ages, and not by the application of the life-table rates at "all ages." The deaths of persons in the last column are obtained by casting the deaths at each group of ages that should occur among males and females, given in the two preceding columns.

N. B.—Each 1,000 of the population of Salford, enumerated in 1871, contained (as shown in columns 2 and 4) 474.97 males and 525.03 females, variously distributed at five groups of ages. Figures in columns 5 and 6 show the yearly number of deaths that should occur at life-table rates at each group of ages and of each sex. The true normal rate for each sex is obtained by dividing the total deaths of males and of females in columns 5 and 6 by the total numbers living of each sex in columns 2 and 4. This gives a normal rate of 22.38 per 1,000 for males and 20.70 per 1,000 for females.

TABLE E.

Population, deaths, and annual rate of mortality in the borough of Salford, during the year 1879, at five groups of ages, compared with the English life-table rates at those ages, for persons, males, and females.

Ages.	Persons.		Males.		Females.	
	Estimated population midsummer, 1879.	Deaths, 1879.	Estimated population midsummer, 1879.	Deaths, 1879.	Estimated population midsummer, 1879.	Deaths, 1879.
All ages						
Under 5 years						
5-20 years						
20-40 years						
40-60 years						
60 years and upwards						

Annual death-rates per 1,000 living among—

Ages.	Persons.		Males.		Females.	
	Salford.	English life-table.	Salford.	English life-table.	Salford.	English life-table.
All ages						
Under 5 years						
5-20 years						
20-40 years						
40-60 years						
60 years and upwards						

TABLE F.

Annual rate of mortality in Salford, during 1879, from five classes of disease at five groups of ages per 1,000 persons estimated to be living at those ages.

Causes of death.	1	2	3	4	5	6
	All ages.	0 to 5 years.	5 to 20 years.	20 to 40 years.	40 to 60 years.	60 years and upwards.
All causes						
Zymotic diseases						
Constitutional diseases						
Local diseases						
Developmental diseases						
Violent deaths						

TABLE G.

Deaths from several causes in the borough of Salford at six groups of ages in 1879, and at all ages in 1878, 1877, 1876, and 1875.

Deaths from—	Deaths at six groups of ages in 1879.						Deaths at all ages.				
	Under 5 years.										
	Under 1 year.	1-5.	5-20.	20-40.	40-60.	60 and upwards.	1879.	1878.	1877.	1876.	1875.
All causes											
CLASS I.											
Zymotic diseases.											
Small-pox											
Measles											
Scarlet fever											
Diphtheria											
Whooping-cough											
Fever. Typhus											
Fever. Enteric											
Fever. Simple continued											
Diarrhœa											
Cholera and choleraic diarrhœa											
Croup (true)											
Puerperal fever											
Rheumatism											
Syphilis											
Delirium tremens and intemperance											
Other zymotic diseases											
CLASS II.											
Constitutional diseases.											
Dropsy											
Cancer											
Other diathetic diseases											
Tabes mesenterica											
Phthisis											
Hydrocephalus											
Other tubercular diseases											
CLASS III.											
Local diseases.											
Apoplexy											
Paralysis											
Epilepsy											
Convulsions											
Other brain diseases											
Heart disease											
Bronchitis											
Pneumonia											
Other lung diseases											
Digestive organs, disease of											
Urinary organs, disease of											
Generative organs, disease of											
Joint disease											
Skin disease											
CLASS IV.											
Developmental diseases.											
Premature birth											
Teething											
Malformation											
Childbirth											
Old age											
Atrophy											
CLASS V.											
Violent deaths.											
Accident											
Homicide											
Suicide											
Not specified											

TABLE H.

Deaths from several causes registered within the borough of Salford, in 1879, in the twelve wards and in public institutions.

Deaths from—	Borough, total.	Trinity.	Islington.	Ordsal.	Regent.	Crescent.	St. Stephen's.	St. Matthias.	Greengate.	St. Thomas.	Seedley.	St. John's.	Kersal.	Work-house.	Fever hospital.	Royal hospital.
All causes																
CLASS I. *Zymotic diseases.*																
Small-pox																
Measles																
Scarlet fever																
Diphtheria																
Whooping-cough																
Fever. Typhus																
Fever. Enteric																
Fever. Simple continued																
Diarrhœa																
Cholera and choleraic diarrhœa																
Croup (true)																
Puerperal fever																
Rheumatism																
Syphilis																
Delirium tremens and intemperance																
Other zymotic diseases																
CLASS II. *Constitutional diseases.*																
Dropsy																
Cancer																
Other diathetic diseases																
Tabes mesenterica																
Phthisis																
Hydrocephalus																
Other tubercular diseases																
CLASS III. *Local diseases.*																
Apoplexy																
Paralysis																
Epilepsy																
Convulsions																
Other brain diseases																
Heart disease																
Bronchitis																
Pneumonia																
Other lung diseases																
Digestive organs, disease of																
Urinary organs, disease of																
Generative organs, disease of																
Joint disease																
Skin disease																
CLASS IV. *Developmental diseases.*																
Premature birth																
Teething																
Malformation																
Childbirth																
Old age																
Atrophy																
CLASS V. *Violent deaths.*																
Accident																
Homicide																
Suicide																
Not specified																

TABLE I.

Certification of the causes of death in 1879.

Wards.	Total deaths.	Certified by—		Not certified.	Proportion per cent. of deaths. Certified by—		
		Registered medical practitioners.	Coroner.		Registered medical practitioners.	Coroner.	Not certified.
Borough of Salford							
Trinity							
Islington							
Ordsal							
Regent							
Crescent							
St. Stephen's							
St. Matthias							
Greengate							
St. Thomas							
Seedley							
St. John's							
Kersal							

TABLE J.

Prices of coal, flour, potatoes, and butchers' meat, and the number of paupers relieved in Salford, 1871 to 1879.

Years.	Average prices of food and fuel. Coal per ton.	Flour per stone.	Potatoes per load.	Butchers' meat per pound.	Pauperism. Weekly average number of paupers relieved during the year.	
1871						
1872						
1873						
1874						
1875						
1876						
1877						
1878						
1879						

SUPPLEMENT No. 6,
National Board of Health Bulletin.

REPORT ON DETERIORATIONS, ADULTERATIONS, AND SUBSTITUTIONS OF DRUGS.

[By C. Lewis Diehl.]

When the writer engaged to furnish the National Board of Health with a report on facts and observations relating to inferiorities in drugs, having not previously given the subject special attention, he had no clear conception of the labor involved in the task, nor of the time that might be required for its completion. As a consequence, he has found the time too short to do complete justice to the work, and his inquiries in several directions are more or less incomplete; while the compilation of the facts gathered has been more hasty than is compatible with smooth work.

In the pursuit of these inquiries, it soon became evident that direct inquiry among those who were presumed to have opportunities for making observations connected with the subject would lead to no satisfactory results. The information thus gained is generally quite vague and general in its character. It is known that such or such a drug, or class of drugs, is particularly liable to be adulterated, or inferior in quality; or that it is understood that the falsification of drugs is still carried on extensively. But when the particulars are asked, they are either not known, or they are too indefinite to be of value. This difficulty has been experienced by all who have made inquiries in this direction, and that experienced by the writer is therefore in no way an exception. As a consequence, he has confined his inquiries mainly to observations that have been from time to time recorded, and particularly to those observations of inferiority in drugs that are on record in the current literature of the last 25 or 30 years. It was furthermore found that the literature upon the subject is by no means as abundant as might be supposed; that, in fact, with the exception of a few papers, mainly general in their scope, the discussion of the question of adulterations of drugs has in the United States been confined to pharmacists; and that in the "Proceedings of the American Pharmaceutical Association," which have been published annually since 1852, almost every noteworthy fact related to inferiority in drugs, that has developed during the past twenty-seven years, has been recorded. The reports, communications, and discussions contained in these "proceedings," together with the standard text-books of pharmacy, and the few papers above referred to, form the scanty "bibliography" appended to this report, and used in its compilation.

GENERAL FACTS RELATED TO, AND INFLUENCING THE CONDITION OF, THE DRUG MARKET IN THE UNITED STATES.

Previous to 1848, and for some years thereafter, the condition of the drug market appears to have been in a very unsatisfactory state indeed. This condition was largely attributed to the importation of adulterated and inferior drugs, which, in the absence of a law specifying a standard of quality, were freely admitted at our ports of entry. During the year mentioned, Congress passed a law regulating the importation of drugs, and designed to exclude inferior and adulterated drugs and medicines; the law going into effect at the port of New York on the 15th of July. Almost immediately the wisdom of this measure manifested itself; for during the first ten months, Dr. M. I. Bailey, the "special examiner of drugs" appointed for the port named, had occasion to reject about 90,000 pounds of drugs—such as rhubarb, opium, jalap, gamboge, senna, yellow bark, iodine, croton oil, sarsaparilla, etc.; while during his entire administration of the office (from 1848 to 1857) he found it necessary to reject over 900,000 pounds of "unsafe, adulterated, and improper drugs and medicines." It is worthy of remark also, and an evidence of the beneficial effects of this wise sanitary measure, that the character and quality of the more important articles of drugs, medicines, and chemicals presented for entry from abroad soon showed decided improvement, and that the importation of inferior and worthless qualities was greatly decreased in quantity. Thus, 19,989 pounds of rhubarb were rejected by Dr. Bailey during the first seven months of his administration of the office named, while during the next two and a half years he had occasion to reject only 5,782 pounds altogether; during the first seven months 3,347 pounds of opium, and during the next two and a half years only 3,164 pounds were rejected, while 70,000 pounds of opium were admitted during the same period; and so with gamboge, myrrh, and other important drugs. At other ports of entry—at Baltimore, Philadelphia, Boston—"special examiners of drugs" appear to have been appointed about the same time as at New York, and, as far as has come to the knowledge of the writer, the experience at these ports has been similar to that of Dr. Bailey.

During the first five or six years of its application, the law appears to have operated remarkably well, notwithstanding certain glaring imperfections, due undoubtedly to the hasty manner in which it was framed and passed through Congress, and which were only slightly modified by a "circular of instruction," issued to special examiners of drugs, on the 4th June, 1853, by the Treasury Department, then under the Secretaryship of Hon. James Guthrie. The more important imperfections which were not affected at all by the "circular of instruction" referred to, and which, inasmuch as there has been no change in the law since its passage, still exist, may be briefly stated to be the following:

1. The failure to provide for the appointment of "special examiners of drugs," absolutely on the ground of their known qualifications for the office, and independent of political preferment or patronage.
2. The failure to make that office distinct and independent, like that of collector, and not subservient to that officer, or, as is really the case, to the appraiser of merchandise.
3. The failure to require strict accountability for his action to the Treasury Department direct, by annual reports of the transactions of his office.
4. The failure to furnish special examiners with appropriate office facilities, and with the necessary books, chemical apparatus, and reagents.

These are among the causes that have made the "drug law" less effective than it should be, and, at periods, almost inoperative; and whatever may be the difference of opinion regarding the three last-named imperfections, there is no doubt the first named is largely responsible for the inefficient and inadequate execution of the law during certain periods of its existence. The removals from this office, up to 1857, on purely political grounds, were so numerous that the law could hardly be said to have had a fair trial up to that time, except at the port of New York; and at this port, through which nearly three-fourths of all importations of drugs were made, Dr. Bailey was also removed in 1857, strictly on political grounds—thereby depriving the service of an officer of acknowledged integrity and zeal and in every way qualified for the responsible office held by him during the preceding nine years.

The condition of things at this period in the history of the drug law may, perhaps, be best explained by the following extract from the final report of a committee on standard of drugs,* appointed by the American Pharmaceutical Association for the purpose of establishing a standard for the guidance of special examiners of drugs. After explaining certain difficulties in the way of establishing standards and advising that the subject be dropped for the present, the committee, of whom the late Prof. William Procter, jr., was chairman, continue as follows: "The committee furthermore felt discouraged from prosecuting the work by the disregard that is paid to proper qualifications in the appointment of officers to carry out the requirements of the drug law. So glaring has this disregard on the part of the Secretary of the Treasury become that designing druggists—at one port where strict scrutiny is administered—have their importations of doubtful nature sent to another port, where a less scrupulous examiner officiates, so that they may be passed. This the committee *know* to be true, and while it continues no amount of accurate standards of quality will benefit the drug market and screen out the adulterated and deteriorated articles." And in a report on "Proposed amendments to the law regulating inspection of drugs," made in the same year to the same association,† Mr. C. B. Guthrie, chairman of the committee, referring to the system of appointment of special examiners of drugs, says: "So many changes have been made that even had good, competent officers been appointed in all cases, as they have not, they would scarcely have become well settled and obtained the requisite facilities for getting through their official duties before they would have been removed to give place to some more hungry applicant." "We are speaking of facrs, well authenticated facts—not fictions, by any means. The result of these changes anyone can see; if not apparent, let them look at the want of uniformity of action at the different ports, and the appearance in market of drugs not seen—some of them—before for years."

The writer has had no access to records relating to the execution of the drug law of a later date than 1857, except such as have been occasionally furnished to the American Pharmaceutical Association, and relating exclusively to quantities of drugs passed or rejected at the different ports and at various periods, and such facts as are related to the rejection of drugs are given in the appendix to this report. He, indeed, has reason to believe that no records exist, except it be in the inaccessible form of manuscript in the custom-houses.

If, however, he may be allowed to offer an opinion based upon information gathered from respectable importers, jobbers, and manufacturers at some of our principal ports of entry, it is to the effect that, while the same system of appointment to the office of special examiner of drugs still prevails, more attention is paid to the fitness

* Proceed. Amer. Phar. Assoc., 1855, 15.
† Proceed. Amer. Phar. Assoc., 1855, 33.

and qualification of applicants, and the execution of the law is in the main satisfactory, though by no means incapable of being improved and rendered more efficient by wise revision.

Another powerful factor in shaping the condition of the drug market has been the organization of pharmacists, already alluded to under the name of the American Pharmaceutical Association. The history of this association is intimately connected with that of the drug law, inasmuch as it is the direct offspring of a convention "held for the purpose of adopting a series of standards for the use of the special examiners of drugs at our different ports, whereby their action might be rendered more uniform and satisfactory." This convention was held pursuant to a call of the New York College of Pharmacy, addressed to the other colleges of pharmacy, on the 15th and 16th October, 1851, and was attended by delegates from the colleges of pharmacy of the city of New York, of Philadelphia, and of Boston. After transacting the business for which the convention was particularly called, a series of resolutions were adopted, favoring a call for a convention of delegates from all incorporated and unincorporated pharmaceutical societies of the United States, to be held during the ensuing year, for the purpose of organizing a permanent "national association"; and in compliance with these resolutions, the president, Mr. C. B. Guthrie, issued a formal call for a "National Pharmaceutical Convention," to meet in Philadelphia on the 6th October, 1852. This convention was duly held, attended by delegates from the Massachusetts, New York, Cincinnati, Philadelphia, and Maryland colleges of pharmacy, from the Richmond Pharmaceutical Society, and by a representative of the apothecaries and druggists of the cities of Hartford and Middletown, Connecticut, resulted in the organization of the "American Pharmaceutical Association," under its present title; an association which, with a single exception (1862) has since met every year, and, as already mentioned, has exerted a powerful influence in shaping the condition of the drug market.

It has done this: By persistently drawing attention to abuses connected with the execution of the drug law, so long at least as its suggestions were not overridden by political influence and policy. By shaping, in an advisory way, standards for the guidance of special examiners of drugs. By establishing a code of ethics for the professional guidance of its members and of pharmacists in general, and by relentlessly exposing all acts in conflict therewith. By collecting information of every kind connected with and to the interest of the drug and apothecary business, and giving it publicity through the annual publication of its proceedings.

In short, it has combated everything that is corrupt, improper, or unfair in the drug business; encouraged the formation of pharmaceutical associations and colleges; established amicable relations between opposing factions, and harmonized conflicting interests. To its beneficent influence largely is due the present fair status of pharmacy in the United States. To enter somewhat more into particulars: The association soon recognized the importance of counteracting a source of inferiority in drugs that is not attributable to imports—that is caused, in one way and another, in our midst. In the report of a committee appointed "to collect such information as may be deemed valuable,"* &c., presented at the meeting of organization above referred to, occurs the following:

"Whatever may be the efficiency of the law against the importation of inferior drugs, it will not reach those at home who are disposed to resort to adulteration as a means of increasing their profits. The power of the general government ceases with the custom-house. It will be necessary in order to reach this evil effectually, as far as it can be done by legislation, to induce our State legislatures and municipal authorities to authorize some form of inspection by which delinquents can be reached; not the drug adulterater merely, but the medicine adulterater—the apothecary who scruples not to reduce the strength of standard medicines, that he may reduce his prices. Whatever may be the proper course of this convention, we believe that eventually the national association should urge with all the force of its influence the enactment of State laws tending to the reformation of these evils." And in the report of a committee "to consider and report on the subject of home adulterations":† "No doubt the sophistication of drugs is as well understood in this country as on the other side of the Atlantic, and that if we could apply a remedy as general in its application, we should detect an amount equally astonishing. This is one of the arguments used by the opponents of the drug law, that medicines can be as readily adulterated here as abroad; but we contend that this is no argument against shutting out foreign adulteration."

The agitatation in this direction resulted in the appointment of a committee on "Home Adulteration," which furnished several interesting reports. In 1861 a standing committee on the "Drug Market" was created, and reports have been received with tolerable regularity since; such reports embracing facts of quality as well as quantity and price of drugs in the market, and not losing sight of adulteration or other causes of inferiority. It soon became evident, however, that the latter subject could be handled better by a special committee, and accordingly, in 1870, a standing committee on "Adulterations and Sophistications" was provided for, with the good result of

* Proceed. Nat. Pharm. Con., 1852, pp. 9 and 10.
† Proceed. Amer. Pharm. Assoc., 1855, p. 25.

a number of exceedingly valuable reports. And from these various reports, as well as from the reports "On the Progress of Pharmacy,"* the known facts of inferiority in drugs have been chiefly compiled.

THE KNOWN FACTS OF DETERIORATIONS, ADULTERATIONS, AND SUBSTITUTIONS OF DRUGS.

At the outset it is necessary that we should clearly understand what constitutes a "deterioration," an "adulteration," and a "substitution," and whether these terms sufficiently cover all the "causes of inferiority" in drugs that have been and continue to be observed.

Causes of inferiority in drugs are of two general kinds—those that are brought about by *accident* and those brought about by *design*. Among the first-named—the accidental causes of inferiority—must be clased the

Deteriorations, by which we understand those natural changes for the worse which take place in drugs by age or exposure. To these changes drugs of vegetable or animal origin are particularly liable, since in many of them a slow change or decomposition, entirely beyond the control of the vender, takes place; and when, in addition to this, either from carelessness or ignorance, such drugs are subjected to improper exposure, the change is all the more rapid and fatal to good quality. Deteriorations may therefore be the result of spontaneous change to which a particular drug, chemical compound, or preparation is liable, as well as of ignorance or carelessness in its preservation. There exist, however, other accidental causes of inferiority which are not covered by the term "deterioration." These are

Impurities and contaminations, introduced either during the collection of the drug or by the process of its manufacture. Such impurities are quite common, and are generally attributable to carelessness or ignorance, except in such crude articles of commerce, the demand and application of which justifies the presence of a certain amount of impurity. All such inferiorities, however, if material in character, can be regarded as accidental only so long as they are not recognized by the vender; for if he knowingly, and under the representation of standard quality, disposes of a drug containing an undue amount of impurity, or otherwise changed to its detriment, his act in no way differs from that of the common adulterater.

Adulterations or sophistications, the terms being synonymous, are the result of design. Perhaps the best definition of what constitutes an adulteration is that given by Dr. A. H. Hassal,† years ago, who says: "It consists in the intentional addition to any article, for the purpose of gain or deception, of any substance or substances, the presence of which is not acknowledged in the name under which the article is sold." When we speak of an adulteration, therefore, there is no room for doubt that we refer to the intentional debasement of an article. On the other hand,

Substitutions may be caused either by accident or design, and may be defined to be the sale of one article in place of and under the name of another. It not unfrequently occurs that collectors of crude vegetable drugs fail to make, or to know, the proper distinction between species, or even mistakenly collect a plant, or its parts, entirely distinct from that intended. In such a case the substitution may be regarded clearly an accidental one; but if the drug-gatherer, or the vender, becomes aware of such a substitution, its offer for sale as the article for which it is substituted is as much an intentional substitution as is that of selling potato starch for arrowroot, or flavored corn whiskey for grape brandy.

And now, having in the foregoing endeavored at some length to explain the character of the influences that have been calculated to operate favorably on the condition of the drug market, and understanding the nature of the causes that may give rise to inferiority in drugs, we may inquire into its present condition as well as into facts of inferiority that may have come to notice within a reasonable period of time. These inquiries lead to the conclusion that—

The drug market must be unqualifiedly pronounced to be fair. That is to say, not that poor and adulterated drugs are absent in the market, or that inferior medicines are not dispensed in our pharmacies, but persons who know, or who really desire to obtain articles of standard quality have very little difficulty in doing so, and, as a general rule, can be suited by respectable dealers throughout the land. On the other hand, ignorant persons or those regulating their purchases by the prices rather than by the quality, and being consequently indifferent as to the character of the dealer, are very likely to meet with low grade and adulterated goods, or, at best, are frequently supplied with goods of an indifferent character.

The principal observations of inferiority in drugs made within the past twenty-five or thirty years, though the larger number have been made during the last decade, are given below in the form of an extensive table (I). A review of this will show that the adulteration of drugs is still largely practised. There exist certain inferiorities, however, in drugs and medicines that it is not desirable or possible to consider within the norrow limits of a tabulated statement, or which, pertaining to classes of drugs, require separate discussion; and this may be briefly done in the following:

Crude vegetable drugs.—The more important crude vegetable drugs

* The Reports on the Progress of Pharmacy give, as the title implies, a concise account of facts and observations relative to pharmacy and its collateral branches, and have been furnished with great regularity since 1857.
† "Food and its adulterations," in "Lancet," 1855.

can, as a rule, be easily obtained in the market of good quality; such, however, as are not often called for are not unfrequently more or less deteriorated in quality, and this is particularly the case with pressed goods. Supposing these drugs to be good of their kind when purchased, much depends upon the length of time required for their consumption and the judgment and care exercised in their preservation. Hence it is of frequent occurrence that an article originally of prime quality is dispensed in a deteriorated condition; and to the extent of such deterioration any preparation made from it must suffer. Furthermore, some drugs, though of good or fair commercial quality, contain more or less extraneous matter, or portions of the plant not recognized as a component, and therefore require careful garbling before dispensing or converting them into medicine. It is believed that in this direction pharmacists often fail with the officinal requirements or to meet the just expectation of the physician.

Powdered drugs.—The powdering of drugs is, unfortunately, very rarely done in our pharmacies at the present day. When done at such, however, the quality is dependent upon the same conditions as those mentioned under "crude drugs." When purchased, as is generally done, powdered drugs are often very inferior, either by being adulterated, or by the practice, which is very common, of using the less sightly and the inferior portions of the drug for that purpose. They have been known and are still known to be subject to the grossest adulterations, this being particularly true of spices and such articles as are frequently handled by grocers as well as druggists. That this practice continues, not only as to grocers' goods, but also as to those exclusively handled by druggists, is shown by the low prices at which powders are often offered; for as late as 1876 the committee of the American Pharmaceutical Association "On the Drug Market"* called attention to the fact that powders are offered at the price of, or at an inadequate advance upon, the crude drug, notwithstanding the loss occasioned in drying and powdering. The proper standard for a powder should be that it accurately represents a good quality of the crude drug, dry and freed from all extraneous matters and impurities; and if we apply such a standard pharmacists are safe only in doing their own powdering, there being but few houses that aim at so high a standard. Nevertheless, powders of fair quality within the above strictures are readily obtained from respectable dealers.

Galenical preparations.—The preparations of the shops as dispensed by some pharmacists will not bear very close scrutiny. Many of them are purchased, and owing to their peculiar character any differences in their strength or quality, whether designed or accidental, are not easily observed, and as a consequence a wide and fruitful field for dishonesty is open to the unscrupulous manufacturer or dealer.

Infusions and *decoctions*, which should properly be made from the drug, are very frequently made by simple admixture of the corresponding fluid extract and water. Numerous instances have come to the knowledge of the writer in which this has been done, and that by persons whose aim it is to sell only pure drugs and who would scorn to sell an article known to be falsified. Such persons often do not appreciate the importance of adhering to the Pharmacopœia, and thus, perhaps, from motives of convenience, are led to substitute. This want of fidelity to the Pharmacopœia in fact is a fruitful cause of variation in medicines, not to speak of inferiorities occasioned by designedly making preparations of less than the standard strength in order to save cost and to undersell.

Solid extracts are rarely made by the pharmacist of to-day, and while some of the manufacturers furnish unexceptionable preparations, those of others are of a very different character, being prepared from inferior or unsalable drugs or by processes devised for saving cost and to the injury of the product. Moreover, this class of preparations is very liable to vary according to the degree of care in their manufacture and preservation, and it is by no means uncommon to find extracts changed by overheating, or that have become moldy and unfit for use by exposure.

Fluid extracts come under the same category as solid extracts. While they are more frequently prepared by the dispenser, still by far the largest proportion consumed is the product of manufacture. These, as found in the market, are good, bad, and indifferent in their quality, and while it is true that many manufacturers aim to supply their patrons with preparations that shall correspond with the requirements of the Pharmacopœia, there are also many others who utterly disregard that standard. They are liable to vary in their strength both on account of quantity and quality of the drug used in their preparation, and when, in addition, the process of preparation varies with the manufacturer, either as regards the manner of exhaustion and concentration, or the quality of the menstruum used in the extraction, we can well account for the unsatisfactory character of many of the fluid extracts furnished in our pharmacies.

Tinctures which, sad to say, are sometimes the extreme limit of pharmaceutical manipulation in some pharmacies have been found to vary very materially in their character and quality. Doubtless much of this is due to unskillful or careless preparation, but it is well known and understood that certain tinctures are made to vary in strength, both of drug and menstruum, in order that they may be sold cheap.

Other preparations could be mentioned which are just as liable to vary in their character, but the causes are in the main the same as those that have been mentioned in connection with the above classes of pharmaceutical preparations, and it is therefore not necessary to enter into further detail. Sufficient has been said to show that the quality of medicines is not alone dependent on a supply of pure drugs by the jobber, but that according to the degree of integrity, qualification, and care of the dispenser the consumer will be supplied with good or with bad medicines.

In now drawing attention to the Table I, exhibiting facts of adulterations and other inferiorities in drugs that have been observed in recent years, some brief explanation is necessary. As mentioned elsewhere, the "table" is compiled mainly from observations recorded in the "Proceedings of the American Pharmaceutical Association," though other sources of information have not been neglected. The "table" shows, after the name of the drug or medicine: 1) whether the observation was made at home (*i. e.*, in the United States) or abroad; 2) the year in which the observation was recorded; 3) the character of the inferiority observed; 4) the name of the observer. If the observation has been recorded in reports to the American Pharmaceutical Association, and the name of the observer has not been distinctly stated in such, the name of the chairman of the committee furnishing the report is given instead; but this fact is designated by appending a single asterisk (thus, *) to the chairman's name, if the report is from the committee on the drug market, or by a double asterisk (thus, **) if the report is made by the committee on adulterations.

TABLE I.—*Showing the principal inferiorities, such as adulterations, substitutions, and deteriorations of drugs, recorded in the current literature of the United States during the past twenty-five or thirty years, but more particularly during the last ten years.*

No.	Drug.	Abroad or at home.	Date.	Character of inferiority.	Observer.
	BARKS.				
1	Angustura	At home	1874	A new false bark described	J. M. Maisch.
1	... do	Abroad	1875	The same bark appears to have been observed in France, and proved to be the bark of *Esenbeckia febrifuga*, Mart.	Oberlin and Schagdenhauffen.
2	Cascarilla		1874	Spurious bark imported into England from Nassau, N. P., believed to be the bark of *Croton lucidum*, L.	E. M. Holmes.
3	Cinchona	At home	1867	The quality of commercial barks is very variable	Wm. A. Brewer.*
3	....do	....do	1871	A large quantity of poor cinchona barks in the market	J. P. Remington.**
3	....do	... do	1873	Worthless bark offered for true calisaya, and also for red bark	J. M. Maisch.
3	....do	Abroad	1873	In Austria, a bark, treated with "chinoidin," to increase alkaloidal strength, offered	Bernatzick.
3	....do	....do	1873	In France, attention is called to a false cinchona bark resembling cinchona, and believed to be derived from a species of "cascarilla." It does not appear to have been offered in the market, however.	Lemoin.
4	Cotton-root	At home	1875	A false bark, the botanical origin of which is not determined, has been offered	J. M. Maisch.
5	Elm	....do	1873	Much of the commercial powder is adulterated with starchy matter, probably flour	P. W. Bedford.*
5	....do	....do	1873	Adulterated in western market with rye-meal	J. H. Schulz.
6	Sassafras	....do	1864	The bark is not thoroughly cleaned; injured by packing while damp, and careless exposure.	J. M. Maisch.*
7	Wild-cherry	....do	1864	Very little of prime quality found in the market; sometimes very inferior	Do.
7	....do	....do	1874	A lot offered largely adulterated with sassafras bark	J. M. Maisch.
	HERBS, LEAVES, ETC.				
8	Belladonna	At home	1863	The article found in the market during 1862–'63 uniformly of bad quality	E. R. Squibb.*
8	....do	....do	1871	Indifferent in quality, owning to bad weather during season of gathering	J. McKesson, jr.*
9	Buchu	....do	1871	A spurious variety, having a different appearance, odor, and taste, offered	Do.
10	Chiretta	Abroad	1875	Substituted by a spurious plant, supposed to be *Ophelia angustifolia*	Bentley.
11	Horsemint	At home	1875	Substituted largely by "wild basil. (*Pycnanthemum incanum*)	Wallace Bros.

* Proceed. Amer. Pharm. Assoc., 1876, 393.

TABLE I.—*Showing the principal inferiorities, such as adulterations, substitutions, &c.*—Continued.

No.	Drug.	Abroad or at home.	Date.	Character of inferiority.	Observer.
–	HERBS, LEAVES, ETC.—Continued.				
12	Hyoscyamus	At home	1871	Indifferent in quality during year	J. McKesson, jr.*
12	....do	....do	1871	Containing 8 per cent. impurities, such as bay leaves, straw, feathers, oats, stone, branches from unknown plant, &c.	O. Eberbach.**
13	Senna	....do	1863	Quality of Alexandria senna generally very low; one sample contained 57 per cent. stems, stone, and dust.	E. R. Squibb.*
13	....do	....do	1868	Good Alexandria senna very scarce during the year	D. C. Robbins.*
13	....do	....do	1871	About one-half has to be garbled away from Alexandria senna, as a general rule	J. P. Remington.**
13	....do	....do	1871	All kinds of senna in the market are indifferent in quality	J. McKesson, jr.*
13	....do	Abroad	1875	Senna, obtained from *Cassia brevipes*, and destitute of purgative properties, in doses of one-half ounce, sold for "fine senna" in London market.	E. M. Holmes.
	FLOWERS, ETC.				
14	Calendula	At home	1871	Adulterated with the florets of *Tagetas erecta*	J. M. Maisch.
15	Elder	....do	1871	Frequently of very inferior quality; largely composed of stalks and deficient in florets.	J. P. Remington.**
16	Pyrethrum	....do	1875	Old stock chamomile flowers ground up with pyrethrum flowers for insect powder. Very little of the imported powder genuine.	A. W. Miller.**
17	Saffron	....do	1864	Most of the saffron of the market is adulterated with safflower	J. M. Maisch.*
17	....do	....do	1871	Chalk (23 per cent.) and gypsum noticed as adulterants several years ago	J. P. Remington.**
17	....do	....do	1873	Two samples of "African" saffron, composed of the florets of *Carthamus tinctorius*, L.; a third sample composed of corollas of scrophulariacum plant, which was afterwards referred by J. R. Jackson, curator at Kew, to *Lyperea crocea*.	J. M. Maisch.
17	....do	Abroad	1873	"Persian cake" saffron almost entirely sophisticated, and containing but few stichmas of genuine crocus.	Dr. H. Hager.
17	....do	At home	1875	Containing 30 to 40 per cent. calendula flowers, dyed with Campeachy wood; 10 to 30 per cent. tiasic sulphate and honey.	A. W. Miller.
–	ROOTS.				
18	Aconite	....do	1872	Quality of root in the market generally bad; often moldy on arrival. Many parcels partially or entirely tasteless, being probably exhausted and redried.	E. R. Squibb.
18	....do	....do	1873	Quality of root not entirely satisfactory	P. W. Bedford.*
19	Angelica	....do	1875	The root of *Archangelica atropurpurea*, *Legusticum actæipolium*, *Aralia spinosa*, and *Heracleum lanatum*, have been found as substitutes for angelica root.	A. W. Miller.
20	Arnica	Abroad	1874	One package containing 50 per cent., another only 10 per cent., of true root imported into England from Germany, the chief adulterant being the root of *Geum erblanum*. D. Hanbury met with a parcel, sold for arnica root, which contained no arnica root at all.	E. M. Holmes.
21	Belladonna	....do	1874	Parcels have been met containing 50 per cent. of malvaceous roots	Do.
22	Colchicum	At home	1863	Rarely met with of good quality during the year	E. R. Squibb.*
23	Cypripedium	....do	1873	Admixed with the rhizomes of *Hydrastis canadensis*, and occasionally with roots of other dicotyledonous plants.	Truckenmüller.
23	....do	....do	1873	The rhizomes of other species of cypripedium noticed in substitution and admixture	J. M. Maisch.
24	Dandelion	....do	1873	Chicory substituted	Charles Rice.
24	....do	....do	1873	So-called "cultivated dandelion" is nothing else than chicory	J. M. Maisch.
24	....do	....do	1874	So-called "American dandelion" is chicory	C. B. Allaise.
24	....do	....do	1875	Substitution of cultivated chicory for dandelion again noticed	F. J. Prentice.
25	Ginger	Abroad	1874	Bleached ginger, to which adhered, on the surface, as much as 2.33 per cent. of a white inorganic powder.	Chas. Rice.**
25	....do	....do	1875	The same observed in France, whitened with lime, and artificially bleached	Patrouillard.
26	Hydrastis	At home	1876	A lot of 500 pounds, composed to the amount of about 50 per cent. of beet root (!!) and containing besides serpentaria, cypripedium, sanguinaria, may-apple root, &c., in admixture, offered in Cincinnati.	O. Eberbach.**
27	Ipecac	....do	1863	Damaged lots, in some cases ship-damaged, have been found in the market	E. R. Squibb.*
28	Jalap	....do	1863	Drug of the market very irregular; composed of small fusiform and very large ones, with few medium tubers, probably the more uniform selected for better markets. Jalap containing 1.8 to 3.3 per cent. of resin only, and therefore probably exhausted partially in Mexico, noticed during 1861–1863.	E. R. Squibb.
28	....do	....do	1868	Good, genuine, heavy Vera Cruz jalap very scarce	D. C. Robbins.*
28	....do	....do	1873	Much inferior jalap in market; under most favorable circumstances the bales contain a considerable number of spongy, light, and inert tubers, not to speak of those of small size. "The custom-house reports show that a large proportion of the jalap imported into this country comes from Europe, and only a small proportion direct from Mexico. The European, chiefly English, market absorbs the best lots, and turns the inferior ones adrift over here."	Chas. Rice.**
28	....do	....do	1873	Ten samples of powdered jalap yielded 16, 13, 11.3, 8.2, 8, 7.2, 6.4, 4.8, 4.5, and 3.6 per cent. resin.	S. H. Ambler.
29	Orris	....do	1873	The powder containing a large percentage of rye-meal	J. H. Schultz.
30	Pareira	Abroad	1874	Composed to the extent of 50 per cent. of the stems of the plant	John Moss.
30	....do	At home	1874	The same adulteration observed in United States	J. M. Maisch.
31	Rhubarb	....do	1868	The supply in the market very ordinary in quality	D. C. Robbins.*
31	....do	....do	1868	Difficult to obtain good rhubarb during the past three years. Rhubarb rejected in the United States custom-house returned to England; there powdered with a lot of superior rhubarb, reshipped to the United States and admitted.	E. R. Squibb.
31	....do	Abroad	1869	Powder adulterated in France with turmeric	Opwyrda.
31	....do	At home	1871	Inferior rhubarb found in the market to some extent. The low price of the powder, the comparative ease with which rhubarb of good or fair quality is obtainable, leads to the inference that inferior rhubarb is largely used for the powder.	E. R. Squibb.
32	Sanguinaria	....do	1875	Turmeric substitued for blood-root in Saint Louis	A. W. Miller.**
33	Sarsaparilla	....do	1871	Quality, particularly of "Honduras," very poor; clay, pieces of foreign roots, large woody pieces of the caudex, &c., and plenty of dirt in the interior of the bundles, which on the outside appear bright and clean.	J. P. Remington.**
33	....do	....do	1876	On garbling some sarsaparilla the following admixtures, showing the carlessness of some dealers, were found: Nut-galls, matico stems; bay, belladonna, and digitalis leaves; paper, bark, straw, ipecac, may-apple.	J. J. Brown.
34	Senega	....do	1871	Considerable quantity of the stems adhering to the roots, and much adhering dirt	J. P. Remington.**
34	....do	....do	1873	The same observation made	P. W. Bedford.*
34	....do	Abroad	1875	Substituted by the root of an *asclepias* in France.	Patrouillard.
35	Serpentaria	At home	1863	Greater portion of that found in the market is inferior, doubtless through deterioration and bad management.	E. R. Squibb.*
35	....do	....do	1873	"Texan" or "Red River" variety substituted for true article	P. W. Bedford.*
35	....do	....do	1874	A spurious article, composed of the rhizomes of *Cypripedium pubescens*, found in the market.	J. M. Maisch.
35	....do	....do	1875	Containing over 12 per cent. of golden-seal root	P.J. Milleman.
35	....do	....do	1876	A small lot contained the following substances in admixture: Fruit of ground-cherry, capsules of unknown plant, stems and leaves of serpentaria, onion peels, charcoal, snail shells, wood, glue, ginseng, gravel.	J. J. Brown.
36	Spigelia	....do	1863	The drug being scarce, quality is of little moment so long as it can be called pink-root.	E. R. Squibb.*
36	....do	....do	1871	Mixed with much dirt	J. McKesson, jr.*
36	....do	....do	1875	Substituted by the root of *Phlox carolina*	S. W. Brown; Wallace Bros.
36	....do	....do	1876	Containing 6 per cent. golden seal, small branches, straw	O. Eberbach.**
37	Valerian	....do	1863	Indifferent and bad varieties abundant	E. R. Squibb.*

TABLE I.—*Showing the principal inferiorities, such as adulterations, substitutions, &c.*—Continued.

No.	Drug.	Abroad or at home.	Date.	Character of inferiority.	Observer.
	ROOTS—Continued.				
37	Valerian	At home	1871	"English" valerian very bad in quality and very dirty.	J. McKesson, jr.
37	....do	Abroad	1871	Mixed with the rhizomes and roots of a species of *veratrum*; probably collected with it.	Bentley.
	SEEDS, FRUITS, ETC.				
38	Anise	Abroad	1875	Russian anise-seed largely composed of the fruit of *Conium maculatum*	A. W. Miller.**
38	....do	....do	1876	Mixed with granular clay—a very common adulteration	O. Eberbach.**
39	Capsicum	At home	1855	Powder composed of turmeric and American capsicum	C. B. Guthrie.**
39	....do	....do	1859	Adulterated with common salt (the powder)!	C. T. Carney.**
39	....do	Abroad	1875	Of 28 samples of powder examined in the English market only 4 were genuine capsicum. The adulterants found were: *red lead*, sometimes in large quantities; *vermilion* in one sample; venetian red, brick-dust, ground rice, turmeric, salt, mustard husks.	A. W. Miller.**
39	....do	At home	1876	Containing 50 per cent. of a mixture of turmeric, wheat, corn-starch, and a little horse-radish.	Professor Harrington.
40	Cardamom	....do	1863	Short, heavy, plum capsules, rare; the long, shriveled, and inferior generally found in the market.	E. R. Squibb.*
40	....do	....do	1873	Containing orange seeds and green coffee	G. W. Kennedy.
41	Coriander	....do	1871	Crop musty and of bad odor, owing to unfavorable weather at time of gathering	J. McKesson, jr.**
42	Cubeb	....do	1859	Containing 15 per cent. of false berries of unknown origin	C. T. Carney.**
42	....do	....do	1873	Containing a large proportion of stalks; powder often very inferior	P. W. Bedford.*
43	Kamala	Abroad	1873	Found in Europe to yield 20.7 to 54.4 per cent. of ash	Dr. Kemper.
44	Larkspur	At home	1875	Substituted, perhaps ignorantly, by slavesacre seeds	A. W. Miller.**
45	Lycopodium	....do	1859	Adulterated with the starch of some species of lentil	C. T. Carney.**
45	....do	Abroad	1868	Six to seven hundred weight from Galicia, composed of the pollen of *Pinus sylvestris*	Potyka.
45	....do	At home	1871	Adulterated with starch	J. P. Remington.**
45	....do	....do	1873	Adulterated with dextrin	B. Lillard.
45	....do	Abroad	1873	Substituted by the pollen of the pine	P. Cazeneuve.
45	....do	....do	1875	Containing talc, powdered resin, and potato-starch to the amount of 8.7 per cent	H. Hager.
46	Mustard	At home	1864	Ground mustard, of English origin, in Coleman's kegs, composed of corn-starch, some potato-starch, turmeric, and capsicum.	J. M. Maisch.*
46	....do	....do	1876	Of eight samples of ground mustard only one pure	Professor Harrington.
47	Pepper	Abroad	1873	A number of specimens of ground pepper, examined in France, showed the presence of dried and ground parenchyma of potatoes (left as residue in the manufacture of starch), lentil flour, chalk, linseed cake, sesame seeds, and grains of paradise.	
47	....do	....do	1876	Whole pepper adulterated with acorns turned into small globes and suitably dyed. (Artificial pepper-corns, made of oil-cake, common clay, and Cayenne pepper were already mentioned by Accum.)	Gehe & Co.
47	....do	....do	1876	Light-weight pepper made equal to the heavy sorts by macerating in salt brine. Adulterants for ground pepper are, pepper leaves, sage, rape-seed, potato, spices, capsicum, Guinea pepper, chicory, rye, laurel leaves, stones from olives, bone-dust, marine salt, and other mineral substances.	A. Winter Blyth.
	EXUDATION PRODUCTS—GUMS, RESINS, BALSAMS, ETC.				
48	Aloes	At home	1871	Socotrine aloes of good quality very scarce	J. McKesson, jr.*
49	Ammoniac	Abroad	1873	Admixed with globular, transparent pieces of quartz, varying in color	Ch. Menière.
50	Assafœtida	At home	1869	Containing sulphate of lime	J. M. Maisch.
50	....do	....do	1873	Several cases passed the New York custom-house containing an unusually large quantity of stone, and almost worthless.	P. W. Bedford.*
50	....do	....do	1873	Containing sand, stone, and other impurities; powder of the market almost odorless	Chas. Rice.**
51	Balsam Peru	....do	1855	Having none of the characters of genuine balsam, except color and consistence, and containing no cinnamic acid.	C. B. Guthrie.**
51	....do	....do	1873	Castor oil, alcohol, and turpentine as adulterants	Chas. Rice.**
51	....do	....do	1874	Adulterated with storax	Schweikert.
52	Balsam Tolu	....do	1859	Containing 15 per cent. of common resin	Chas. T. Carney.**
52	....do	....do	1864	Spurious; composed chiefly of Burgundy pitch; evidently put up in United States, in packages resembling the original.	J. M. Maisch.*
52	....do	....do	1875	Containing common resin in large quantities	B. Bückle.
52	....do	....do	1876	Containing 63 per cent. of a balsam prepared from *Liquidambar orientale*, 11 per cent. of bark and charred ligneous matter.	R. V. Mattison.
53	Benzoin	....do	1873	Containing 25 per cent. impurities	Curtis.
53	....do	....do	1873	Hemlock bark found in admixture	J. H. Schulz.
54	Copaiba	....do	1859	"Pará" copaiba, containing 6 to 8 per cent. fat oil	Chas. T. Carney.**
54	....do	....do	1871	Factitious copaiba, manufactured in Indiana	J. P. Remington.**
54	....do	....do	1872	Containing castor oil	E. S. Wayne.
54	....do	....do	1873	Containing resin and linseed oil	T. N. Jamison.
54	....do	....do	1876	Factitious copaiba, composed of linseed oil, castor oil, turpentine, and sufficient copaiba to give odor.	J. M. France.
55	Dragon's blood	....do	1876	Apparently a mixture of oxide of iron and common resin	Henry Bretet.
56	Gum Arabic	....do	1871	The powder adulterated with sand and marble dust	J. P. Remington.**
56	....do	Abroad	1873	The whole gum adulterated with dextrine in fine grains	Dr. H. Hager.
57	Guaiac	At home	1871	The quality generally very common	J. McKesson, jr.*
57	....do	....do	1875	Containing 20 to 26 per cent. impurities	L. C. Hogan.
58	Labdanum	Abroad	1876	Mixed during the melting process with olibanum, mastic, and other resins	X. Landerer.
59	Myrrh	At home	1868	Fine qualities very scarce	D. C. Robbins.*
59	....do	....do	1868	Admixed with sulphate of lime	J. M. Maisch.
60	Opium	....do	1855	Containing 20 per cent. of foreign matter, chiefly lead; powder adulterated to the extent of 50 per cent.	C. B. Guthrie.**
60	....do	....do	1859	Powder containing less than 3 per cent. morphia	Chas. T. Carney.**
60	....do	....do	1863	Much inferior opium in the market because of the indiscriminate sale of "prize goods" by the government.	E. R. Squibb.*
60	....do	Abroad	1868	"Smyrna" opium was found to be adulterated as follows, according to variety: *Macedonian* with clay; *Angora* with pieces of wax; *Amasia* with cherry gum; *Taushanly* with extract of licorice; *Balukhissar* with fused colophony; occasionally, also, entire cakes were factitious, and evidently composed in their interior of clay and cow's dung.	Dr. C. Finckh.
60	....do	At home	1871	Containing 14 per cent. of starch	J. T. King.
60	....do	Abroad	1871	Opium (in Italy!) observed which contained 30 per cent. of green leaves, supposed to be tobacco, finely chopped, together with small, roundish balls of an undetermined substance.	Righini.
60	....do	....do	1874	Gum senegal as adulterant, in England	Stoddart.
60	....do	....do	1874	Containing 10 per cent. of earthy matter, in England	Attfield.
60	....do	At home	1874	Containing gummy matter	J. T. King.
61	Opoponax	Abroad	1875	Entirely substituted by myrrh	J. H. Marais.
62	Pitch, Burgundy	At home	1871	Very little true in the market	J. P. Remington.**
62	Pitch, hemlock	....do	1875	Spurious; supposed to be a mixture of common pitch and resin	J. A. Scheidt.
63	Scammony	....do	1860 / 1862	Thirty-two samples of "Virgin" scammony yielded resin, as follows: One, 25 per cent.; six, 25 to 30 per cent.; eight, 30 to 40 per cent.; five, 40 to 50 per cent.; seven, 50 to 60 per cent.; four, 60 to 70 per cent.; three (of which two were special importations), over 70 per cent. According to "Regulations of the Treasury Department" virgin scammony is admitted only when containing 70 per cent. of pure scammony resin.	E. R. Squibb.

TABLE I.—*Showing the principal inferiorities, such as adulterations, substitutions, &c.*—Continued.

No.	Drug.	Abroad or at home.	Date.	Character of inferiority.	Observer.
–	HERBS, LEAVES, ETC.—Continued.				
12	Hyoscyamus	At home	1871	Indifferent in quality during year	J. McKesson, jr.*
12	....do	....do	1871	Containing 8 per cent. impurities, such as bay leaves, straw, feathers, oats, stone, branches from unknown plant, &c.	O. Eberbach.**
13	Senna	....do	1863	Quality of Alexandria senna generally very low; one sample contained 57 per cent. stems, stone, and dust.	E. R. Squibb.*
13	....do	....do	1868	Good Alexandria senna very scarce during the year	D. C. Robbins.*
13	....do	....do	1871	About one-half has to be garbled away from Alexandria senna, as a general rule	J. P. Remington.**
13	....do	....do	1871	All kinds of senna in the market are indifferent in quality	J. McKesson, jr.*
13	....do	Abroad	1875	Senna, obtained from *Cassia brevipes*, and destitute of purgative properties, in doses of one-half ounce, sold for "fine senna" in London market.	E. M. Holmes.
	FLOWERS, ETC.				
14	Calendula	At home	1871	Adulterated with the florets of *Tagetas erecta*	J. M. Maisch.
15	Elder	....do	1871	Frequently of very inferior quality; largely composed of stalks and deficient in florets.	J. P. Remington.**
16	Pyrethrum	....do	1875	Old stock chamomile flowers ground up with pyrethrum flowers for insect powder. Very little of the imported powder genuine.	A. W. Miller.**
17	Saffron	....do	1864	Most of the saffron of the market is adulterated with safflower	J. M. Maisch.*
17	....do	....do	1871	Chalk (23 per cent.) and gypsum noticed as adulterants several years ago	J. P. Remington.**
17	....do	....do	1873	Two samples of "African" saffron, composed of the florets of *Carthamus tinctorius*, L.; a third sample composed of corollas of scrophulariacum plant, which was afterwards referred by J. R. Jackson, curator at Kew, to *Lyperca crocea*.	J. M. Maisch.
17	....do	Abroad	1873	"Persian cake" saffron almost entirely sophisticated, and containing but few stichmas of genuine crocus.	Dr. H. Hager.
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39	Capsicum	At home	1855	Powder composed of turmeric and American capsicum	C. B. Guthrie.**
39	....do	....do	1859	Adulterated with common salt (the powder)?	C. T. Carney.**
39	....do	Abroad	1875	Of 28 samples of powder examined in the English market only 4 were genuine capsicum. The adulterants found were: *red lead*, sometimes in large quantities; *vermilion* in one sample; venetian red, brick-dust, ground rice, turmeric, salt, mustard husks.	A. W. Miller.**
39	....do	At home	1876	Containing 50 per cent. of a mixture of turmeric, wheat, corn-starch, and a little horse-radish.	Professor Harrington.
40	Cardamom	....do	1863	Short, heavy, plum capsules, rare; the long, shriveled, and inferior generally found in the market.	E. R. Squibb.*
40	....do	....do	1873	Containing orange seeds and green coffee	G. W. Kennedy.
41	Coriander	....do	1871	Crop musty and of bad odor, owing to unfavorable weather at time of gathering	J. McKesson, jr.**
42	Cubeb	....do	1859	Containing 15 per cent. of false berries of unknown origin	C. T. Carney.**
42	....do	....do	1873	Containing a large proportion of stalks; powder often very inferior	P. W. Bedford.*
43	Kamala	Abroad	1873	Found in Europe to yield 20.7 to 54.4 per cent. of ash	Dr. Kemper.
44	Larkspur	At home	1875	Substituted, perhaps ignorantly, by slavesacre seeds	A. W. Miller.**
45	Lycopodium	....do	1859	Adulterated with the starch of some species of lentil	C. T. Carney.**
45	....do	Abroad	1868	Six to seven hundred weight from Galicia, composed of the pollen of *Pinus sylvestris*	Potyka.
45	....do	At home	1871	Adulterated with starch	J. P. Remington.**
45	....do	....do	1873	Adulterated with dextrin	B. Lillard.
45	....do	Abroad	1873	Substituted by the pollen of the pine	P. Cazeneuve.
45	....do	....do	1875	Containing talc, powdered resin, and potato-starch to the amount of 8.7 per cent	H. Hager.
46	Mustard	At home	1864	Ground mustard, of English origin, in Coleman's kegs, composed of corn-starch, some potato-starch, turmeric, and capsicum.	J. M. Maisch.*
46	....do	....do	1876	Of eight samples of ground mustard only one pure	Professor Harrington.
47	Pepper	Abroad	1873	A number of specimens of ground pepper, examined in France, showed the presence of dried and ground parenchyma of potatoes (left as residue in the manufacture of starch), lentil flour, chalk, linseed cake, sesame seeds, and grains of paradise.	
47	....do	....do	1876	Whole pepper adulterated with acorns turned into small globes and suitably dyed. (Artificial pepper-corns, made of oil-cake, common clay, and Cayenne pepper were already mentioned by Accum.)	Gehe & Co.
47	....do	....do	1876	Light-weight pepper made equal to the heavy sorts by macerating in salt brine. Adulterants for ground pepper are, pepper leaves, sage, rape-seed, potato, spices, capsicum, Guinea pepper, chicory, rye, laurel leaves, stones from olives, bone-dust, marine salt, and other mineral substances.	A. Winter Blyth.
	EXUDATION PRODUCTS—GUMS, RESINS, BALSAMS, ETC.				
48	Aloes	At home	1871	Socotrine aloes of good quality very scarce	J. McKesson, jr.*
49	Ammoniac	Abroad	1873	Admixed with globular, transparent pieces of quartz, varying in color	Ch. Menière.
50	Assafœtida	At home	1869	Containing sulphate of lime	J. M. Maisch.
50	....do	....do	1873	Several cases passed the New York custom-house containing an unusually large quantity of stone, and almost worthless.	P. W. Bedford.*
50	....do	....do	1873	Containing sand, stone, and other impurities; powder of the market almost odorless.	Chas. Rice.**
51	Balsam Peru	....do	1855	Having none of the characters of genuine balsam, except color and consistence, and containing no cinnamic acid.	C. B. Guthrie.**
51	....do	....do	1873	Castor oil, alcohol, and turpentine as adulterants	Chas. Rice.**
51	....do	....do	1874	Adulterated with storax	Schweikert.
52	Balsam Tolu	....do	1859	Containing 15 per cent. of common resin	Chas. T. Carney.**
52	....do	....do	1864	Spurious; composed chiefly of Burgundy pitch; evidently put up in United States, in packages resembling the original.	J. M. Maisch.*
52	....do	....do	1875	Containing common resin in large quantities	B. Bückle.
52	....do	....do	1876	Containing 63 per cent. of a balsam prepared from *Liquidambar orientale*, 11 per cent. of bark and charred ligneous matter.	R. V. Mattison.
53	Benzoin	....do	1873	Containing 25 per cent. impurities	Curtis.
53	....do	....do	1873	Hemlock bark found in admixture	J. H. Schulz.
54	Copaiba	....do	1859	"Pará" copaiba, containing 6 to 8 per cent. fat oil	Chas. T. Carney.**
54	....do	....do	1871	Factitious copaiba, manufactured in Indiana	J. P. Remington.**
54	....do	....do	1872	Containing castor oil	E. S. Wayne.
54	....do	....do	1873	Containing resin and linseed oil	T. N. Jamison.
54	....do	....do	1876	Factitious copaiba, composed of linseed oil, castor oil, turpentine, and sufficient copaiba to give odor.	J. M. France.
55	Dragon's blood	....do	1876	Apparently a mixture of oxide of iron and common resin	Henry Bretet.
56	Gum Arabic	....do	1871	The powder adulterated with sand and marble dust	J. P. Remington.**
56	....do	Abroad	1873	The whole gum adulterated with dextrine in fine grains	Dr. H. Hager.
57	Guaiac	At home	1871	The quality generally very common	J. McKesson, jr.*
57	....do	....do	1875	Containing 20 to 26 per cent. impurities	L. C. Hogan.
58	Labdanum	Abroad	1876	Mixed during the melting process with olibanum, mastic, and other resins	X. Landerer.
59	Myrrh	At home	1868	Fine qualities very scarce	D. C. Robbins.*
59	....do	....do	1868	Admixed with sulphate of lime	J. M. Maisch.
60	Opium	....do	1855	Containing 20 per cent. of foreign matter, chiefly lead; powder adulterated to the extent of 50 per cent.	C. B. Guthrie.**
60	....do	....do	1859	Powder containing less than 3 per cent. morphia	Chas. T. Carney.**
60	....do	....do	1863	Much inferior opium in the market because of the indiscriminate sale of "prize goods" by the government.	E. R. Squibb.*
60	....do	Abroad	1868	"Smyrna" opium was found to be adulterated as follows, according to variety: *Macedonian* with clay; *Angora* with pieces of wax; *Amasia* with cherry gum; *Taushanly* with extract of licorice; *Balukhissar* with fused colophony; occasionally, also, entire cakes were factitious, and evidently composed in their interior of clay and cow's dung.	Dr. C. Finckh.
60	....do	At home	1871	Containing 14 per cent. of starch	J. T. King.
60	....do	Abroad	1871	Opium (in Italy !) observed which contained 30 per cent. of green leaves, supposed to be tobacco, finely chopped, together with small, roundish balls of an undetermined substance.	Righini.
60	....do	....do	1874	Gum senegal as adulterant, in England	Stoddart.
60	....do	....do	1874	Containing 10 per cent. of earthy matter, in England	Attfield.
60	....do	At home	1874	Containing gummy matter	J. T. King.
61	Opoponax	Abroad	1875	Entirely substituted by myrrh	J. H. Marais.
62	Pitch, Burgundy	At home	1871	Very little true in the market	J. P. Remington.**
62	Pitch, hemlock	....do	1875	Spurious; supposed to be a mixture of common pitch and resin	J. A. Scheidt.
63	Scammony	....do	1860 / 1862	Thirty-two samples of "Virgin" scammony yielded resin, as follows: One, 25 per cent.; six, 25 to 30 per cent.; eight, 30 to 40 per cent.; five, 40 to 50 per cent.; seven, 50 to 60 per cent.; four, 60 to 70 per cent.; three (of which two were special importations), over 70 per cent. According to "Regulations of the Treasury Department" virgin scammony is admitted only when containing 70 per cent. of pure scammony resin.	E. R. Squibb.

TABLE I.—*Showing the principal inferiorities, such as adulterations, substitutions, &c.*—Continued.

No.	Drug.	Abroad or at home.	Date.	Character of inferiority.	Observer.
	EXUDATION PRODUCTS—Continued.				
63	Scammony	At home	1874	Adulterated with 23 to 29 per cent. of flour	Chas. Rice.**
63	do	Abroad	1874	Containing guaiac resin	H. W. Jones.
63	do	do	1875	While every sample of whole scammony of the market (in England) was free from starch, every sample of powder examined contained more or less scammony-starch, and occasionally wheat starch.	Thomas Greenish.
64	Turpentine, Canada	At home	1871	So-called "Oregon balsam" substituted and sold for balsam of fir	J. McKesson, jr.*
64	do	do	1874	"Oregon balsam" again noticed in the market. This is apparently a factitious article, composed of resin and oil of turpentine, and flavored with oil of eucalyptus and oil of nutmeg. It could not be traced further than New York.	J. M. Maisch.
	FIXED OILS.				
65	Almond	do	1859	"True English" oil of almonds composed principally of linseed oil	Chas. T. Carney.**
66	Cacao	do	1873	A mixture of wax and palm oil sold in the Chicago market for cacao-butter	T. N. Jamison.
67	Castor	do	1873	Containing 95 per cent. of whale oil	T. N. Jamison.
67	do	do	1875	Composed of lard oil, with a little croton oil	A. W. Miller.**
68	Cod-liver	do	1867	Undoubtedly considerable quantities of so-called "shore oil" substituted for cod-liver oil.	Wm. A. Brewer.*
69	Neat's-foot	do	1873	Containing 25 to 33 per cent. kerosene oil	Chas. Rice.**
70	Olive	do	1871	Paraffine oils, having a fine yellow color and rendered odorless by some process, largely used as adulterant.	P. W. Bedford.
70	do	do	1875	"Olive oil" is bottled in New York, the cheaper grades being cotton-seed oil, the better grades oil of benne. It is mixed abroad to an enormous extent with ground-nut oil.	A. W. Miller.**
71	Palm	Abroad	1873	Containing 50 per cent. and 57.5 per cent. water	Tissandier; Hager.
72	Wax	At home	1867	Containing tallow, Japan wax, or paraffine	Wm. A. Brewer.*
72	do	Abroad	1873	Ceresin substituted for white wax; impure paraffine, colored with turmeric, for yellow wax.	Chas. Rice.**
72	do	At home	1875	In Philadelphia market, with paraffine to 80 per cent.; one lot of "yellow wax" composed entirely of black earthy matter, coated very nicely with handsome yellow wax.	A. W. Miller.**
	VOLATILE OILS.				
73	Almond	do	1859	Sometimes composed entirely of essence of mirbane (nitro-benzole)	Chas. T. Carney.**
73	do	do	1873	Same adulteration observed	Chas. Rice.**
74	Amber	do	1865	Adulterated with kerosene and with oil of turpentine	A. E. Ebert.
75	Bergamot	do	1859	Containing 30 per cent. alcohol	C. T. Carney.**
75	do	Abroad	1875	A factitious article, made with oil of orange, copaiba, lemon, and neroli, is said to be made in Europe and sold in large quantities.	A. W. Miller.**
76	Cade	At home	1876	Common tar flavored with oil of juniper	J. M. France.
77	Chamomile	do	1876	Castor oil and alcohol flavored with pure oil and colored with litmus	Do.
78	Cinnamon	do	1875	Containing oil of sassafras and oil of cloves	A. P. Brown.
79	Cloves	Abroad	1871	Containing carbolic acid (Hager) and copaiba	J. P. Remington.
79	do	do	1876	Containing 40 per cent. of a light, oxygenated, volatile oil, the nature of which has not been determined.	E. Schaer.
80	Erigeron	At home	1875	Adulterated largely with oil of turpentine	J. L. Lemberger.
81	Fennel	do	1856	Rejected at port of Baltimore because containing much oil of turpentine	Prof. Aiken.
82	Horsemint	do	1867	Much of that in the market fails to answer the tests of purity	Wm. A. Brewer.*
83	Juniper berries	do	1856	Refused entry at Baltimore because adulterated with oil of turpentine	Prof. Aiken.
83	do	do	1875	Containing 80 per cent. of alcohol	A. W. Miller.**
84	Lemon	do	1856	Rejected at Baltimore; containing oil of turpentine	Prof. Aiken.
84	do	do	1868	Containing petroleum oil (M.); paraffine oil (D.)	Maisch; Diehl.
84	do	do	1873	Very poor lots offered during the year	P. W. Bedford.*
84	do	do	1875	One package containing 25 per cent. of alcohol; another, in addition, 40 per cent. of castor oil—both original, but probably counterfeited, packages.	A. W. Miller.**
85	Mustard	do	1868	Containing alcohol	Cumney,
85	do	Abroad	1875	Apparently adulterated with oil of wintergreen	H. Hager.
86	Peppermint	At home	1855	Containing 50 per cent. of alcohol	C. B. Guthrie.**
86	do	do	1867	Much of the oil of commerce fails to answer to tests of purity	Wm. A. Brewer.*
86	do	do	1873	Numerous lots of tainted and tampered oil offered	P. W. Bedford.*
86	do	Abroad	1873	In Canada, a lot offered containing 38.18 per cent. of castor oil and 29.10 per cent. of alcohol.	Shuttleworth.
86	do	At home	1874	Western oil adulterated with some terebinthinate hydrocarbon	C. Schulze.
86	do	do	1875	A 25-pound can contained but 8½ pounds of pure oil, the remainder being castor oil and alcohol in about equal proportion.	A. W. Miller.
86	do	do	1876	Containing 10 to 20 per cent. of oil of pennyroyal	O. Eberbach.**
87	Rose	do	1871	Adulterated with a mixture of castor oil and alcohol	J. P. Remington.**
87	do	do	1876	Containing spermaceti	A. W. Miller.
88	Rose, geranium	do	1875	Difficult to obtain the true oil, which is substituted by the oil of *Andropogon Schoenanthus*.	A. W. Miller.**
89	Santal	do	1873	Much of the commercial oil sophisticated to some extent	P. W. Bedford.*
89	do	do	1873	Containing 50 per cent. of castor oil	T. N. Jamison.
89	do	do	1874	Thick, of weak odor, and smelling of copaiba	A. P. Brown.
90	Sassafras	do	1867	A very considerable quantity of the oil of commerce is impure	Wm. A. Brewer.*
90	do	do	1875	Containing 14 per cent. of resin	A. W. Miller.
91	Verbena	do	1875	True oil almost out of the market; everywhere substituted by oil of lemon-grass (*Andropogon citratus*).	Do.
92	Wintergreen	do	1867	Much impure oil in the market	Wm. A. Brewer.*
92	do	do	1874	Containing 20 per cent. of chloroform	W. H. Pile.
92	do	do	1874	Composed of one part of true oil with four to five parts of oil of sassafras	Chas. Rice.**
92	do	do	1875	Containing two-thirds of its volume of alcohol; also some containing oil of sassafras	A. W. Miller.
93	Wormseed	do	1875	Apparently containing rancid turpentine	J. L. Lemberger.
94	Wormwood	do	1856	Containing alcohol, and on that account refused entry at Baltimore	Prof. Aiken.
94	do	do	1875	Adulterated with a large proportion of oil of turpentine	A. W. Miller.**
	MISCELLANEOUS DRUGS.				
95	Agaric	do	1875	Substituted by a species of *Agaricus*, to which a bitter taste was communicated by coating the surface with some powder of true larch agaric.	J. M. Maisch.
96	Arrowroot	Abroad	1873	Common grades of arrowroot imported into Bermuda and thence exported as true Bermuda arrowroot.	P. W. Bedford.*
96	do	do	1876	Tacca-starch sold as Bermuda arrowroot	H. P. Madsen.
97	Castor	At home	1855	The follicles filled with sawdust to half the weight of the castor	C. B. Guthrie.**
98	Cochineal	Abroad	1869	Five samples observed, containing 8, 12, 16, 18, and 25 per cent. of sulphate of barium, ingeniously caused to adhere to the insect.	M. Himmelman.
99	Ergot	At home	1873	Much of the small-sized ergot imported contains the ergotized grains of barley, oats, and perhaps other graminaceæ.	Chas. Rice.**
99	do	do	1876	A lot of powder found in the market, which was entirely factitious and bearing no resemblance to the drug.	Henry Trimble.
100	Guaiac wood	do	1873	Of eleven samples examined only one contained resin	J. H. Schulz.
101	Honey	do	1873	Substituted by glucose, probably flavored with the flowers of the locust tree (*Robinia pseudo-acacia*).	Chas. Rice.**
101	do	do	1875	Cane, or other sugar melted in a decoction of slippery elm, or in a solution of gum or starch, flavored with West India honey and "essence" (?).	A. W. Miller.**
101	do	do	1876	Composed entirely of sirup made from corn starch	J. M. France.
102	Irish moss	Abroad	1874	An admixture of 40 per cent. of *Gigartina acicularis*, L., noticed in France	J. Dalmon.

TABLE I.—*Showing the principal inferiorities, such as adulterations, substitutions, &c.*—Continued.

No.	Drug.	Abroad or at home.	Date.	Character of inferiority.	Observer.
	MISCELLANEOUS DRUGS—Continued.				
103	Musk	Abroad	1875	A cady of 19½ ounces "true Tonquine musk," contained only 6¼ ounces of musk, the remainder being earthy matter.	S. W. Miller.**
104	Soap, castile	At home	1863	Formerly of uniform quality; "now debased to an incongruous mixture often of filthy fats and alkalies, with as much water as science and skill can put into solid form."	E. R. Squibb.*
104	... do	... do	1871	Often contains 30 per cent., or more, of water	J. P. Remington.**
104	... do	... do	1871	Substituted by cocoanut-oil soap	A. E. Ebert.
105	Tapioca	... do	1859	An entirely factitious article, made from potato starch, imported from Liverpool	Chas. T. Carney.**
	CHEMICALS.				
106	Acid, acetic	... do	1871	Deficient in strength and containing sulphuric acid	J. P. Remington.**
106	... do	Abroad	1873	Containing manganese and iron. Vinegar, in the Liverpool market, containing much hydrochloric acid.	Chas. Rice.**
106	... do	... do	1874	Containing much sulphuric acid, deficient in strength, and containing over 8 per cent. glucose.	Do.
107	Acid, butyric	... do	1873	One-third of its weight proved to be capronic acid; *butyric ether*, probably made from this impure acid, contained much water, alcohol, acetic ether, propionic ether, and as much capronic as butyric ether.	Burgemeister.
108	Acid, citric	... do	1874	Adulterated with crystals of tartaric acid	Stoddart.
108	... do	At home	1875	Same adulteration observed in American market	A. W. Miller.**
109	Acid, hydrocyanic	Abroad	1874	Eight samples of officinal and three of Scheele's acid, of the English market, all found to be deficient in hydrocyanic acid.	Chas. Rice.**
110	Acid, muriatic	At home	1873	Containing much chloride of lead	E. Scheffer.
110	... do	... do	1874	"C. P." acid containing sulphurous acid and arsenic	A. E. Ebert.
111	Acid, phosphoric	... do	1874	Containing arsenic	L. Thompson.
112	Acid, sulphuric	... do	1871	Ordinary acid adulterated with sulphate of sodium and sulphate of magnesium to increase specific gravity.	J. Fleuschner.
112	... do	... do	1871	So-called "C. P." acid containing sulphate of lead	J. P. Remington.**
113	Acid, tartaric	... do	1867	A considerable quantity of tartaric acid in Boston market adulterated with 25 to 50 per cent. sulphate of sodium; believed to have been introduced through sales of "prize goods" by United States Government.	Wm. A. Brewer.*
113	... do	... do	1874	A lot containing a large percentage of alum offered by a large manufacturing firm in New York.	Chas. Rice.**
114	Æther	... do	1863	Ordinary ether, while stronger than officinally required, is often quite unclean; stronger ether generally weaker than it should be, and often unclean.	E. R. Squibb.*
115	Æther, spir. comp	... do	1863	Of eleven commercial specimens not one, in any way, approached the officinal requirements.	Do.
116	Æther, spir. nitrous	... do	1863	Same as the compound spirit; deficient both in ether and in alcohol (*i. e.*, contains water).	Do.
117	Ammon., carbon	... do	1871	A factitious article, made in Chicago from water of ammonia, glue, and bicarbonate of sodium, which greatly resembles ordinary carbonate of ammonium.	J. M. Maisch.
118	Ammon., liquor	... do	1871	Often of insufficient strength and quality	J. P. Remington.**
119	Ammon., sulphate	Abroad	1873	Crude article found to contain so much sulphocyanite of ammonium as to be unfit even as a fertilizer.	Chas. Rice.**
120	Antim. et pot. tart	At home	1859	Containing 21 per cent. foreign matter	Chas. T. Carney.**
120	... do	... do	1871	Containing 8 to 11 per cent. cream of tartar in admixture	J. P. Remington.**
121	Antim., sulphuret	... do	1871	Containing galena; quartz to the amount of 30 or 40 per cent.; clay, &c	Do.
121	... do	... do	1873	A lot in the western market, not containing a trace of antimony and supposed to be galena.	T. N. Jamison.
122	Bismuth	... do	1871	Antimony offered for metallic bismuth	J. P. Remington.**
123	Bismuth, subnitrate	... do	1871	Adulterated with 28 per cent. phosphate of calcium	Do.
123	... do	Abroad	1873	Nitrate of ammonium in undue quantity, from process of manufacture, as impurity	Bultot.
124	Bromine	... do	1873	Cyanogen not an uncommon impurity	Phipson.
124	... do	At home	1876	Containing 10 per cent. of bromoform	Reyman.
125	Calcium, carb. precip	... do	1871	Containing much iron	J. P. Remington.**
125	Calcium, carbon	Abroad	1875	Burnt bones substituted for prepared oyster shell	E. Heintz.
126	Calcium, chloride	At home	1871	Containing much caustic lime	A. E. Ebert.
127	Calcium, phosphate	Abroad	1873	Contaminated with lead	Chas. Rice.**
128	Iodine	At home	1873	Crude article containing 25 per cent. of saw-dust	J. P. Remington.
128	... do	Abroad	1873	Containing 28.75 per cent. of iodide of cyanogen	Dr. G. C. Wittstein.
128	... do	... do	1874	Containing 5 to 22 per cent. of water, 0.30 to 0.92 per cent. chlorine, and 0.40 to 1.11 per per cent. ash.	Gaston Tissandier.
129	Iodoform	At home	1871	Containing a considerable proportion of substance—not determined—which is insoluble in ether.	J. P. Remington.
130	Iron, by hydrogen	... do	1873	A lot from one of the largest manufacturing houses in the United States, containing 30 per cent. of carbon.	Chas. Rice.**
130	... do	... do	1874	The quality of the commercial article leaves much to be desired; the proportion of metallic iron which it contains is even less than several years since.	J. Creuse.
131	Iron, chloride	... do	1873	Solution of ferric chloride, diluted with water and containing no alcohol at all, sold as tincture.	Chas. Rice.
132	Iron, iodide	Abroad	1873	The sirup contaminated with lead; traced to crude iodine employed in its preparation	Attfield; Williams; Umney.
133	Iron and quinia citr	At home	1873	Containing 4.3 to 10 per cent. quinia (should contain 16 per cent.)	P. W. Bedford.
133	... do	Abroad	1873	Of eight samples in the English market only two contained the officinal quantity of quinia, the others containing from 5 to 12 per cent.	A. W. Gerrard.
133	... do	At home	1875	So-called "English style" citrate of iron and quinia varied between 3 and 6 per cent. of quinia.	L. C. Hogan.
134	Lead, acetate	... do	1871	Containing a large percentage of nitrate of lead; composed, in another case, entirely of damaged sulphate of zinc caked so as to form lumps.	A. E. Ebert.
135	Magnesia	... do	1873	Imported heavy magnesia adulterated with Rochelle salts	R. V. Mattison.
135	... do	... do	1873	Calcined and carbonate containing iron as impurity	Chas. Rice.**
136	Magnesia, sol. citr	... do	1873	Officinal solution substituted by solution of tartrate or citrate of sodium	Do.
136	... do	... do	1871	Tartrate of sodium substituted	J. P. Remington.**
136	... do	... do	1874	Contaminated with lead, evidently derived from impurity in citric acid	F. A. Reichard.
137	Manganese, oxide	... do	1873	Generally very inferior—impure and deficient in oxide	T. N. Jamison.
138	Morphia, sulph	... do	1871	Substituted completely by some mineral substance in a western city; in New York sulphate of quinia put up in morphia bottles and sold as morphia.	J. P. Remington.**
139	Mercury, corros. chlor	... do	1859	Adulterated with common salt	Chas. T. Carney.**
139	... do	Abroad	1873	But partially soluble; supposed to be derived from residues of aniline manufacture (in France).	Bultot.
140	Mercury, ammon	... do	1874	Adulterated with gypsum	Stoddart.
141	Mercury, oxide, precip	... do	1874	Contaminated with carbonate of calcium	Dr. Godeffroy.
142	Piperin	At home	1859	Adulterated with small crystals of yellow prussiate of potash	Chas. T. Carney.**
143	Potass., bitart	... do	1855	Cream of tartar of commerce, containing 33 per cent. carbonate of calcium	C. B. Guthrie.**
143	... do	... do	1859	Containing 63.33 per cent. farinaceous matter and sold as "pure" cream of tartar; another lot containing acid sulphate of sodium; another containing 25 per cent. of selenite, or sulphate of calcium, technically called the "great adulterater."	Chas. T. Carney.**
143	... do	... do	1873	Adulterated with corn starch	P. W. Bedford.*
143	... do	... do	1873	Seventeen samples purchased mainly from respectable dealers (3 wholesale, 7 retail drug houses, the remainder grocers), were all more or less impure, containing from 6 to 44 per cent. tartrate of calcium; some, in addition, carbonate of calcium. One contained as much as 89.5 per cent. tartrate of calcium; another, 92.9 per cent. terra alba.	W. G. Rothe.
14	... do	... do	1873	One sample composed mainly of carbonate of calcium; another, of sulphate of calcium, a little cream of tartar, and some starch and flour.	E. Scheffer.

TABLE I.—*Showing the principal inferiorities, such as adulterations, substitutions, &c.*—Continued.

No.	Drug.	Abroad or at home.	Date.	Character of inferiority.	Observer.
	CHEMICALS—Continued.				
143	Potass., bitart	At home	1873	A sample containing 5 to 6 per cent. tartrate of calcium, 8 per cent. ammonia alum, and 2 per cent. starch.	G. W. Kennedy.
143	....do	....do	1873	A sample containing 77 per cent. alum	J. M. Merrick.
143	....do	....do	1874	The usual impurities reported in a large number of samples	T. C. Hussey.
144	Potass., bromide	...do	1873	Containing over 5 per cent. of chloride as impurity	E. Smith.
144	....do	Abroad	1873	Of ten samples in France only one pure. Contained from 10 to 15 per cent. impurities, and one even 35 per cent., consisting of carbonate, iodide, and sulphate.	Adrian.
145	Potass., chlorate	...do	1873	In Belgium a lot containing 15 per cent. of bicarbonate of potassium	Bruylants.
145	....do	....do	1875	Lead as impurity	A. Hilger.
146	Potass., iodide	At home	1873	Containing 9 per cent., and over, of bromide of potassium	Toussaint.
146	....do	Abroad	1874	Containing 10 per cent. of iodate of potassium	Stoddart.
147	Quinia salts	At home	1855	Mannite found in sulphate; in another case finely picked cotton was introduced into the bottles to increase bulk.	C. B. Guthrie.**
147	....do	...do	1871	Salicine substituted for quinia sulphate in Philadelphia	J. P. Remington.**
147	....do	.. do	1873	Muriate of cinchonia put up, under Pelletier's brand, for sulphate of quinia	P. W. Bedford.*
147	....do	Abroad	1873	Sulphate containing 10 per cent. of anhydrous sulphate of sodium	J. Biel.
147	....do	....do	1873	Sulphate of quinidia substituted for sulphate of quinia in England	Chas. Rice.**
147	....do	....do	1875	Containing one-third carbonate of sodium. A lot of "sulphate of quinia" exported to India, contained, according to an analysis of Howard & Sons, London, not a trace of any of the cinchona alkaloids.	A. W. Miller.**
148	Santonin	At home	1871	Containing mica	J. P. Remington.**
148	....do	....do	1874	Adulterated with 22 per cent. boric acid	Dr. F. Hoffmann.
148	....do	....do	1875	Entirely substituted by picric acid	W. L. Harrison; J. M. Maisch.
149	Silver, nitrate	...do	1859	Lunar caustic, from Kentucky, sold as pure, containing but 10 per cent. of the metal	Chas. T. Carney.**
150	Sodium, chloride	...do	1874	Kanawha salt, No. 1, containing nearly 4 per cent. of chloride of barium as impurity	E. Scheffer.
151	Sodium and potass. tart	...do	1871	Containing 25 per cent. sulphate of sodium	J. P. Remington.**
152	Sodium, phosphate	...do	1875	Containing more than half its weight of sulphate	Dr. A. B. Lyon.
153	Sulphur	...do	1871	Flowers of sulphur containing 50 per cent. gypsum	J. P. Remington.**
154	Sulphur, precipit	Abroad	1869	Containing 66 per cent. of sulphate of calcium	Prof. Attfield.

THE MODES OF INTRODUCTION OF INFERIOR AND FALSIFIED DRUGS AND MEDICINES INTO COMMERCE AND USE.

To state the facts of inferiority in drugs is, to some extent, also to point out the modes of their introduction; hence, this inquiry has, in some directions, been already answered in the preceding. This is particularly true of accidental inferiorities, such as are brought about by carelessness or ignorance, the modes of introduction of which have been made sufficiently clear by what has been already said in reference to their occurrence. The present inquiry may therefore be confined almost exclusively to the consideration of the inferiorities that are introduced designedly.

If, as has been stated before, it is difficult to secure information respecting facts of adulteration observed in the open market, how much more difficult must it be to obtain information respecting modes whereby such adulterated goods are introduced into commerce and use, particularly if we reflect that the successful introduction of falsified or inferior goods is dependent almost exclusively upon the ability of the perpetrators of such to conceal their act. The discussion of this subject must therefore be largely conjectural and based upon the character of inferiorities observed in drugs. What such inferiorities may be is shown in the table (II) immediately following this inquiry.

Adulterations have been practiced from the earliest times and in the remotest ages, and are likely to be practiced in all time to come. The motive, also, has at all times been, and will continue to be, the same—cupidity. The methods, however, are subject to change, progressing with the advance of science. Nearly sixty years ago Mr. Frederick Accum,* a chemist of renown, declared that adulterations were managed with all the order and method of regular trade, and that it might be distinguished as an "art and mystery." And if that was true sixty years ago, it is reasonable to assume that at the present time falsifications are practiced with the increased knowledge and facilities afforded by the rapid development of chemistry and kindred sciences. But this development also makes it necessary that the falsifications should be of a more subtile character than formerly, since it has, in like manner, led to readier methods of detection. Hence, gross methods of adulteration are now not as frequently practiced as formerly, and when practiced upon drugs are soon brought to the light.

The writer is unable to point out any establishment or locality where drugs and medicines are falsified at the present day, though the occurrence of falsified drugs in the market points out the fact that such establishments—whether extensive or not is immaterial—still exist. During former years, however, such establishments were known. Before the drug law went into operation immense quantities of spurious, falsified, and worthless drugs were imported; indeed, on the authority of Dr. M. I Bailey, nearly one-half of the drugs imported into New York before the year 1848 were of this worthless description. At that time establishments existed in various parts of Europe—in England, Belgium, Germany, France—where drugs and medicines were "prepared with a special view to their sale in the United States." In one of his reports† Dr. Bailey draws attention to a firm in Brussels who had erected an extensive establishment exclusively devoted to the adulteration and imitation of the most important medicinal chemicals, and whose products gave evidence of the most consummate skill. There was subsequently evidence that this same firm, or some of its members—their products being debarred from entry by the drug law—engaged in the same work in the United States. In this country the existence of establishments where adulterations are regularly practiced have been pointed out from time to time, and as late as 1871 Prof. I. P. Remington* drew attention to the fact that certain wholesale houses have rooms set apart for the purpose of "mixing" powders; and one house in particular, in a western city, is mentioned, having a regularly organized adulterating department, with a foreman and all appliances necessary for adulterating. The most successful field for the adulteration is doubtless that of powdered drugs, in which, owing to their physical condition, it is often quite difficult to detect foreign admixture. Indeed, so systematic has been the practice of adulterating powdered drugs that in many drug mills regular formulas for the preparation of "pure and genuine" powders were in use (see "Pulveres," Table II), and, for aught that is known to the contrary, are still in use. In this pernicious practice all classes of trade—manufacturers, jobbers, and retailers—are often implicated, some of them sending the adulterant with the drug to be powdered, while others require a return of as much powder, weight for weight, as of crude drug sent, and then, as it were, forcing the drug miller to make up the loss occasioned in drying and powdering by some foreign and less expensive substance.

Then, again, volatile oils are still adulterated to a shameful extent. Dr. A. W. Miller, in his report on adulterations and sophistications of drugs,† 1875, mentions the fact that it is a common practice among small distillers of essential oils, such as cedar, hemlock, spruce, &c., to put the branches of the respective trees into the still along with an amount of turpentine proportioned to the price they expect to realize. He was also shown a full line of receipts for mixing and cheapening all the more important oils, by a person who formerly held responsible positions in two of the largest houses in Germany dealing exclusively in essential oils, while the official representative of an extensive French firm, of Grasse, informed him that "all the cheap grades of lavender, rosemary, and origanum or red thyme, sent to this country, both by themselves and other manufacturers, contained at least 75 per cent. of turpentine."

It is not possible, however, within the narrow limits of this report to enter into further particulars. Suffice it to say that inferior and adulterated drugs are introduced into commerce and use by modes which vary as much as do the causes of their inferiority. The drug-gatherer, often an ignorant or poorly educated person, and being, moreover, generally inadequately compensated for his labor, is not always careful in the selection, collection, or treatment of the drug, and thus, at the very outset, vitiates its quality. From the gatherer the drug passes into the hands of the dealer, who will assort his purchases according to the market for which they may be designed, and in this way good and inferior grades are established. The drug is now ready for the market, and upon the demand of this market, in a great measure, depends the character of the drug supplied to it. If the demand is for good drugs and there is a disposition to pay fair prices, the market will be supplied with such; but if the demand is regulated by the price rather than by the quality, then the supply will naturally accommodate itself to the demand and inferior grades

* A Treatise on the Adulteration of Food, 1822.

† Report on the Practical Operation of the Law relating to the Importation of Adulterated and Spurious Drugs and Medicines, &c., by M. I. Bailey, M. D., &c., in N. Y. Jour. Med., 1849, III, 47-64.

* Report of the Committee on Adulterations and Sophistications of Drugs, Proceed. Amer. Pharm. Assoc., 1871.

† Proceed. Amer. Pharm. Assoc., 1875, 495.

will prevail. In this demand for cheap goods, in fact, lies the prime motor to all falsifications and substitutions. If the importer, in sending out his order to his agent, limits the price, so that he may compete or even undersell with a large profit, his agent, endeavoring to meet the demand, will scour the market until he finds that article that is suitable in price. He does not inquire as carefully into the history of the particular parcel purchased as he would if his action were not so limited; or where several grades of the same drug exist, he will purchase that which nearest accommodates itself to the demand; and in this way it occurs that goods of inferior or sophisticated quality reach our ports of entry, where they are subjected to the scrutiny of the special examiner of drugs, and according to the degree of vigilance of this officer, as well as of the character of the inferiority, such inferior goods may be refused entry or passed. Owing to certain defects in the law, probably also to the incapacity or carelessness now and then of the examining officers, the admittance of inferior goods is not at all infrequent; and it is a positive fact that at the present day drugs are admitted from abroad that are far from satisfactory in quality, while others are decidedly inferior or even adulterated.

By reference to Table II the causes of inferiority in drugs and medicinal chemicals and preparations will be readily understood. Admitting, for the sake of argument, that all of these inferiorities exist in our market at the present day, it is not difficult to understand how inferior drugs, whether imported from abroad or produced in our midst, are distributed in commerce and brought into use. It must be remembered that among dealers in drugs and medicines, those who have qualified themselves by a systematic course of study are the exception and by no means the rule, and that qualifications so obtained are not always a safeguard against dishonest practices. The great majority of druggists enter upon their business solely as tradesmen and with the view to making money, and being in their particular branch subject to as great temptations as those engaged in other branches of trade, they enter into competition and undersell each other until their business no longer returns a profit. Under these conditions the conscientious dealer struggles along, supplying good medicines, maintaining fair prices as best he can, eking a precarious living, or, as is sometimes the case, giving up his business in despair. It is quite different, however, with the dealer who possesses an elastic conscience, and who regards his business first from the standpoint of trade and last from that of ethics. He is bound to succeed at all hazards, and enters into keen competition. With him Peruvian bark is Peruvian bark, and rhubarb is rhubarb; and if he can buy the one for seventy-five cents or a dollar, why should he pay two dollars and a quarter for what is offered as true Calisaya bark? or, if he can obtain the other at fifty or sixty cents, why should he pay one dollar and a quarter for a select article of rhubarb? With him that manufacturer is the best who gives him the largest discount on his goods; and if, perchance, he should find that a preparation is invoiced to him at a price which is inadequate to pay for the material used in its manufacture, he marvels at the progress made in the production of pharmaceutical preparations, and becomes all the more confirmed in his view that it does not pay to make them himself. He is keen at a bargain; does not hesitate to overstock his shop with medicines of a fugitive character so he can obtain them below the market price, and, in short, regulates his purchases exclusively with a view to selling cheap. And in this he is, in a great measure, supported by the public, who fail to appreciate the fact that commerce furnishes as many grades of quality in drugs as among other articles, and that it is easier to meet competition in price than competition in quality.

Attention is now asked to "Table II," showing the causes of inferiorities, of whatever nature, that have been observed in drugs and chemicals. This table is given in support of some of the views expressed in the foregoing as well as for general information. It has been carefully compiled from standard text books of pharmacy, such as the "U. S. Dispensatory," of Wood and Bache; the "National Dispensatory," of Stillé and Maisch; "Handbuch der Pharmaceutischen Praxis," of Hager; and "Pharmacographic," of Flückiger and Hanbury. While it is believed to give an accurate exhibit of causes of inferiority that deserve consideration, it has been the aim of the compilator to include only the more important substances, and to omit all those, whether important or not, that have not been known to be purposely adulterated. Such is true of many chemical compounds, which are subject only to accidental impurity, and are nowadays readily obtained in commerce in a condition of sufficient purity for the purposes of medicine. The table embraces the following points: 1. Whether the drug is imported or domestic. 2. Where it is produced. 3. Inferiorities resulting from impurities or deteriorations. 4. Inferiorities resulting from adulterations or substitutions. 5. The quality of the drug as at present attainable in the market.

TABLE II.—*Showing the causes of inferiorities in drugs and chemicals as given in acknowledged standards of pharmacy and medicine.*

No.	Drug.	Imported or domestic.	Where produced.	Causes of inferiority.		Commercial quality.
				Impurities and deteriorations.	Adulterations and substitutions.	
1	Absinthium	Both	Europe; cultivated in United States.	Age; loss of volatile oil	Coarse stems of the plant	Fair.
2	Acacia	Imported	Kordofan and other parts of Africa; occasionally India.	Extraneous matter, owing to careless collection. The powder liable to become musty and lumpy by exposure to dampness.	Inferior gum, which is sometimes bleached. Feronia gum substituted or admixed. Dextrine occasionally (in powder), flour, or starch.	Good.
3	Acid, acetic, (ordinary, glacial, dilute; vinegar.)	Both	Prepared largely in United States. Imported also from Europe.	Empyreumatic products; sulphuric, sulphurous, and hydrochloric acids. Vinegar, occasionally contaminated with metallic salts, such as tin, lead, copper.	Vinegar is often made from inferior and filthy material, such as beer slops, &c.; sometimes made altogether artificially; mineral and other acids added to give strength.	Variable. The strength of acetic acid as well as of vinegar is often deficient; in most samples of the former empyreuma, but good acid is obtainable.
4	Acid, arsenious	Imported	Europe	Arsenious acid, in lumps, sometimes contains sulphide of arsenic. The common "white arsenic," always more or less impure, owing to crude method of production.	The common powder often largely adulterated with sulphate of barium or with gypsum.	Arsenious acid in lumps, generally of good quality.
5	Acid, benzoic	Both	Mainly in Europe; to a small extent only in United States.	Acquires an unpleasant odor when made from hippuric acid and not sufficiently purified. May contain cinnamic acid from variety of benzoin.	Carbonate of calcium, asbestos, boracic acid, oxalic acid, sugar. Artificial acid substituted for acid made from benzoin.	Acid from gum not often met in the market; artificial acid, obtained from naphthalin or from hippuric acid, being generally found in the market.
6	Acid, carbolic	Imported	England and Germany chiefly.	May contain, according to quality, cresol, pyrol, rosolic acid, naphthalin, paraffine, benzole, and other hydrocarbons.	Impure grades sold for pure; solar and other paraffine oils are sometimes added to common grades.	Good. If colorless not necessarily pure, since the purest grades obtainable are liable to acquire a pink tint.
7	Acid, citric	Both	To some extent in United States, but mainly in England; largely also in Germany.	Traces of lead, lime, and sulphuric acid.	Tartaric acid, sulphate of sodium, nitrate of sodium, oxalic acid.	Readily obtained, of good quality.
8	Acid, gallic	do	Largely in United States; much imported from Germany.	Coloring matter, a little tannin, and resinous substances, from carelessness in manufacture.	Tannin, dextrine, sugar, various mineral substances.	Good.
9	Acid, hydrocyan	do	United States	Readily decomposed on keeping, depositing a brown substance, becoming weaker and finally inert.	Sulphuric and hydrochloric acids.	Fair.
10	Acid, lactic	Imported	Largely in Germany	Coloring and extractive matters, undecomposed lactates, mineral salts, introduced by careless manufacture.	Mannite, sugar, gum, glycerine; tartaric, phosphoric, and citric acids.	Fair.
11	Acid, muriatic	Domestic	United States	The crude acid sometimes contains arsenic and lead; nearly always iron; not unfrequently sulphuric acid, sulphurous acid, and free chlorine—all due to crude method of manufacture.	Owing to crude method of manufacture the crude acid of commerce is sometimes so inferior as to be unfit for pharmaceutic uses. Often obtained as a by-product.	So-called "C. P." acid generally of fair quality. Common acid very variable.

TABLE II.—*Showing the causes of inferiorities in drugs and chemicals, &c.*—Continued.

No.	Drug.	Imported or domestic.	Where produced.	Causes of inferiority.		Commercial quality.
				Impurities and deteriorations.	Adulterations and substitutions.	
12	Acid, nitric	Domestic	United States	Hyponitric acid and iron; saline compound, chlorine, muriatic and sulphuric acids introduced during careless or crude process of manufacture.	Undue quantities of impurities; variation in strength.	Readily obtained medicinally pure, but rarely of the strength required by the U. S. pharmacopœia. Crude acid variable.
13	Acid, oxalic	Both	United States and Europe.	Impurities introduced by crude process of manufacture.	Binoxalate and quadroxalate of of potassium. Tartaric, citric, and racemic acid—introduced probably accidentally—have been noticed.	Variable.
14	Acid, phosphoric	....do	The glacial acid in Europe, particularly Germany; the diluted acid in United States.	The glacial acid may be deficient in strength, owing to the presence of water. The diluted acid may contain, as accidental impurities, sulphuric, hydrochloric, nitric, and phosphorous acid, arsenic, lead, phosphate of sodium.	The glacial acid sometimes adulterated with calcium, magnesium, or sodium phosphates; the latter in considerable amount, to give it solidity.	Glacial acid variable; diluted acid fair.
15	Acid, salicylic	Imported	Mainly in Germany; said to be made in the United States under Kolbe's patent, but the fact is not evident.	Impurities are incidental to the process of manufacture, the chief of which, according to I. Williams (1878), is cresyl-salicylic acid. Carbolic, sulphuric, and hydrochloric acids; mineral impurities and coloring compounds.	Acid of inferior quality and purity sold for pure goods.	Quality variable, but pure acid readily obtained.
16	Acid, succinic	....do	Principally in Germany.	Empyreumatic, odorous, and coloring compounds.	According to Hager, very prone to adulteration. Muriate of ammonium, chloride of sodium, sulphate, bisulphate, tartrate, and bitartrate of potassium; alum; alkaline nitrates; oxalic acid and oxalates; citric acid and citrates; lactose and glucose.	Variable.
17	Acid, sulphuric	Domestic	United States	The crude acid always contains lead and nitrogen compound, introduced by the process. Sometimes, but rarely in U. S., also arsenic. The C. P. acid sometimes contains lead, owing to careless manufacture.	The crude acid sometimes contains sulphate of sodium, to increase specific gravity.	The C. P. acid is rarely as strong as required by the U. S. P. Crude acid variable in quality.
18	Acid, sulphurous	....do	......do	By age and exposure is converted into sulphuric acid, and also loses gaseous sulphurous acid.	Deteriorated acid sold for good.	Variable by reason of ready deterioration.
19	Acid, tannic	Both	United States and Europe.	Coloring and resinous matter.	Dextrine and mineral matters of various kinds.	Good.
20	Acid, tartaric	....do	Europe, (England), United States.	Traces of sulphate of calcium and lead; not unfrequently also sulphuric acid, all from process of manufacture.	Alum, borax, sulphate and nitrate of sodium.	Generally good.
21	Acid, valerian	....do	Europe and United States.	Acetic and butyric acid; amyl-valeaianate, &c., all from process of manufacture.	Sulphuric and hydrochloric acid; water.	Fair.
22	Aconitum root	Imported	High mountainous regions of Europe.	Variable in strength according to period of collection. Changed by improper exposure.	The tubers of other species of aconitum, inferior in strength, are occasionally mixed with or substituted for those of *A. napellus*. The root of *Imperatoria ostruthium* substituted.	Fair.
23	Æther	Domestic	United States	Foreign ethereal compounds introduced by impurities in alcohol, and insufficient purification.	Ether deficient in strength, and impure substituted for stronger ether.	Fair.
24	Æther, acetic	Both	United States and Europe.	Acetic acid and foreign ethers introduced by process of manufacture and insufficient purification.	Water and alcohol	Often deficient in strength.
25	Agaric, alb	Imported	Central and Southern Europe; Northern Asia.	....	Other kinds of agaric substituted.	Fair.
26	Alkanna	....do	Southern Europe and Western Asia.	By exposure to sunlight the coloring matter is destroyed.	The roots deprived of the bark, which contains the coloring matter, sometimes composes a large proportion of the drug.	Variable.
27	Aloes	....do	Barbadoes, Cape of Good Hope, Socotra, &c.	Extraneous impurities introduced by process of preparation.	Extraneous impurities in undue quantities. Inferior grades substituted for the more valuable.	Care must be exercised in purchasing the prepared grades, both whole and powder.
28	Althaea	....do	Europe and Asia Minor.	Liable to become mouldy	Inferior roots whitened by lime. The roots of allied species, inferior in mucilage, sometimes substituted.	Good.
29	Ammoniacum	....do	Persia and Tartary	Varies according to care of collection.	Pebbles and other extraneous matter introduced.	Fair.
31	Ammonium, bromide	Both	United States and Europe.	Bromate of ammonium	Chloride of ammonium	Good.
32	Ammonium, carbonate	Imported	Chiefly in England	Occasionally empyreumatic matter. Readily loses ammonia and becomes bicarbonate.	Factitious carbonate, made with bicarbonate of sodium, glue, and ammonia water.	Variable owning to ready change.
33	Ammonium, chloride	....do	....do	Ferrous and ferric chloride. Occasionally empyreumatic matter.	....	Ordinary article always impure. Purified readily obtainable of good quality.
34	Ammonium, iodide	Domestic	United States	Very readily decomposed by keeping.	Bromide, chloride, and occasionally sulphate of ammonium.	Variable owing to ready change.
35	Ammonium, nitrate	....do	....do	Chloride of sulphate	Chloride and sulphate in considerable proportion.	Good.
36	Ammonium, sulphate.	Both	United States and England.	Empyreumatic and other impurities, resulting from process, such as sulphocyanide of ammonium, &c.	Sulphocyanide in very large proportion.	Variable.
37	Ammonium, valerianate.	Domestic	United States	Liable to contain excess of acid.	Fixed alkalies; sulphate, phosphate, chloride, and acetate of ammonium.	Good.

TABLE II.—*Showing the causes of inferiorities in drugs and chemicals, &c.*—Continued.

No.	Drug.	Imported or domestic.	Where produced.	Causes of inferiority.		Commercial quality.
				Impurities and deteriorations.	Adulterations and substitutions.	
38	Amygdalæ, amara ...	Imported ...	Southern Europe and Northern Africa.	Liable to attack of insects	Sweet almonds mixed with bitter.	Fair.
39	Angustura	....do	South America	Liable to change by being badly kept.	Substituted by the bark of *Strychnos nux vomica*; also by that of *Esenbeckia febrifuga*.	Good.
40	Anisum	....do	Eastern and Central Europe, and countries bordering on the Mediterranean.	Very prone to change by exposure and dampness.	Sand, clay, and other earthy matter. The fruits of *Conium maculatum*.	Fair.
41	Anthemis	....do	Southern and Western Europe.	Very liable to change by age and exposure.	The flowers of *Anthemis arvensis*, L., *Maruta cotula*, D.C., *Matricaria chamomilla*, L., *Pyrethrum parthenium*, *Achillea ptarmica*.	Varies according to age and season.
42	Antimonii et potass. tart.	Domestic ...	United States	Tin, lead, copper, *arsenic*, chlorides, sulphates—all from careless manufacture.	Bitartrate of potassium	Fair.
43	Antimonii, oxysulph..	....do	..... do	May vary with the process followed, and may contain arsenic.	....	Good.
44	Antimonii, sulphuret (native).	Imported ...	Europe	Naturally varies in percentage of available antimony.	Coal dust; mixtures of powdered coal and chalk.	Very variable.
45	Arnica (flowers, rhizome).	....do	......do	*Root* occasionally found with the radical leaves attached. *Flowers* liable to attack of insects and to change by age and exposure.	*Root* mixed (or entirely substituted) with that of *Genum urbanum* and other composite plants; *flowers* with other yellow composite flowers.	Good.
46	Arum	Domestic ...	United States	Liable to attack of insects	The roots of *Arum maculatum* substituted.	Variable.
47	Assafœtida	Imported ...	Persia, Afghanistan, &c.	Extraneous matter introduced by careless collection.	Earthy admixtures, sometimes to 40 per cent.; pieces of translucent gum.	Fair.
48	Aurantii, cortex	Both	*Sweet*, United States; *bitter*, chiefly from Mediterranean and West Indies.	Varies according to care in collection and keeping.	....	Fair.
49	Balsamum Peruvianum.	Imported ...	San Salvador	Extraneous matter	Alcohol, fixed and volatile oils, copaiba, gurjun balsam, Canada turpentine, asphaltum, storax, benzoin. Very subject to adulteration.	Fair to variable.
50	Balsamum Tolutanum.	....do	Venezuela and New Granada.	Sand and other extraneous matter introduced by process of collection.	Storax, resin, turpentine	Variable.
51	Belæ fructus	....do	India	....	The fruit of *Feronia elephantum*, Corr., sometimes substituted.	(!)
52	Belladonna (leaves, root).	....do	United States, but generally from Europe.	Roots very prone to change	Old, woody roots sometimes substituted. Leaves adulterated or admixed with those of other solanaceous plants.	Fair.
53	Benzoinum	....do	Sumatra, Siam	Varies according to source, generally containing more or less extraneous matter.	Containing undue quantity of extraneous matter; inferior grades substituted for the better.	Fair.
54	Bismuthum (subcarbonate, subnitrate).	Both	United States, Europe.	Arsenic, tin, lead, antimony, iron, nickel, zinc, from carelessness in manufacture; nitrate of ammonium.	Carbonate of calcium; magnesium.	Good.
55	Brominum	Domestic ...	Now almost exclusively in United States.	Chlorine, iodine, bromoform	....	Good.
56	Buchu	Imported ...	South Africa	Flowers and capsules of the plant in "short" buchu.	Long buchu with the leaves of *Epleurum serrulatum*.	Good.
57	Cadmium, salts	Both	United States and Europe.	May contain metals of the zinc group, earths, and alkaline earths; now and then arsenic, lead, and copper—all due to insufficient purification.	....	Good.
58	Calcium, bromide	Domestic ...	United States	Chloride, nitrate, and bromate.	....	Good.
59	Calcium, carbonate ...	Both	United States and England.	Chloride; iron, alumina—remaining from process of manufacture if precip. carbonate.	Phosphate and sulphate of calcium—the latter sometimes completely substituted for precipitated carbonate.	Good.
60	Calcium, phosphate ...	....do	United States principally.	Chloride of ammonium	Carbonate and sulphate of calcium.	Good.
61	Calendula	Imported ...	Southern Europe and the Levant.	By exposure the color changes from yellow to whitish.	Substituted and adulterated by the flower-heads of *Tagetes erecta*, L., and *T. patula*, L.	Fair.
62	Calumba	....do	Mozambique and Eastern Africa.	Not unfrequently worm-eaten ..	*Bryonia* roots and those of *Frasera Walteri* sometimes substituted.	Good.
63	Calx, chlorinat	....do	England, principally ..	Liable to absorb moisture, and to lose chlorine by exposure.	Undue proportion of unchanged lime.	Good.
64	Canella	....do	West Indies and Florida.	....	The bark of *Cinnamodendron corticosum* has been substituted.	Good.
65	Cantharis	....do	Southern and Central Europe and Western Asia.	Suffers by age and exposure; liable to be attacked by mites.	Powder sometimes adulterated with euphorbium. The flies sometimes extracted with alcohol and redried. Rendered weighty with fixed oils. Admixed with other insects.	Variable on account of liability to change.
66	Carum	Both	Chiefly in Europe; cultivated to a limited extent in United States.	Liable to mustiness and other changes by exposure; may contain much chaff.	Exhausted by distillation and redried. The fruits of *Ægopodium podagraria* have been substituted.	Fair or good, according to season.
67	Caryophyllus	Imported ...	East Indies, tropical Africa, Brazil, and West Indies.	By age becomes inferior, loses volatile oil, &c.	Deprived of volatile oil by bisulphide of carbon, and appearance of such, as well as of old and dry cloves, restored by fixed oils. Powder adulterated with various substances.	Variable. Good quality can always be obtained at an advanced price over ordinary. Powder sometimes shamefully adulterated.

TABLE II.—*Showing the causes of inferiorities in drugs and chemicals, &c.*—Continued.

No.	Drug.	Imported or domestic.	Where produced.	Causes of inferiority.		Commercial quality.
				Impurities and deteriorations.	Adulterations and substitutions.	
68	Cascarilla	Imported	Bahamas	Suffers by age and exposure; varies according to selection.	A spurious bark, probably from *Croton lucidus*, L., has been found admixed with the genuine.	Good.
69	Cassia fistula	do	East and West Indies.	Liable to attack of insects and to become moldy.	The pods of other species of cassia substituted.	
70	Castoreum	do	Siberia and British North America.		American castor sold for true Siberian. Occasionally adulterated with mixtures of blood, earthy and resinous matter, and even substituted altogether by artificial sacs.	Variable.
71	Catechu	do	East Indies and Ceylon.	Varies according to commercial grade, and often contains considerable quantities of extraneous matter.	Color heightened by the addition of bichromate of potassium. Clay, sand, insoluble organic deposits from vegetable infusions; occasionally alum.	Good qualities easily obtained.
72	Cera	Both	Supplies are principally produced in United States.	Honey; extraneous substances of various kinds. White sometimes insufficiently bleached.	Ceresin, paraffine, and vegetable wax from various sources used as adulterants and substitutions of white wax. The same, as well as resin, stearine, suet, and similar fats, in yellow wax. White lead and flour to increase weight.	Good.
73	Cetaceum	Imported	Pacific and Indian Oceans.	Liable to become rancid and to acquire a yellowish color if insufficiently purified.	Stearine and other solid fats as adulterants.	Good.
74	Chiretta	do	Northern India		Other species of *Ophelia* are known as substitutes, and have been occasionally brought into the market as chiretta.	Good.
75	Chloral, hydrate	Both	United States and Germany.	Hydrochloric or sulphuric acid; water. Liable to spontaneous change.	Chloral alcoholate	Good.
76	Chloroform	do	do	Often insufficiently purified, containing foreign chlorinated compounds. Liable to spontaneous change when too strong, particularly when exposed to light, with formation of phosgene gas.	Impure chloroform sold for pure.	Some manufacturers furnish a pure chloroform at fair prices. Others seem to be entirely oblivious to the necessity of furnishing chloroform of even moderate purity.
77	Chondrus	Domestic	United States and Europe.	Varies according to care in collection and preservation.	*Chondrus mamillosus*, Gr. (having, however, the same general properties), sometimes substituted.	Varies; but a good article is readily obtainable at an advance over the price of the ordinary.
78	Cinchona	Imported	South America; cultivated in East Indies, Java, &c.		Inferior barks are often sold and substituted for those of known value. Spurious barks were formerly met, but are now very rare. Poor barks enriched with chinioidine.	Good barks can be obtained from respectable dealers. There is, however, much inferior bark in the market, which, owing to ignorance or for other reasons, is demanded by dealers.
79	Cinnamom. and Cassia lignea.	do	Ceylon, China, and East Indies.	Both varieties vary, according to care in collection, age, and exposure.	The cheaper cinnamon barks, known by the general term "Cassia lignea," are sometimes substituted for true cinnamon. Inferior grades of cassia sold for the better grades. Powder often adulterated in various ways by spice-dealers.	Both varieties are obtainable, of good quality, according to grade.
80	Coccus	do	Mexico, Central America, West Indies, and Canary Islands.		Earthy matter, carbonates of lead, sulphate of barium, bone-black, &c., applied to the surface of the insects by means of gum-water. The fully developed females of *Coccus ilicis*, Fabr., sometimes substituted.	Fair.
81	Colchicum	do	Southern and Central Europe.	By age and exposure the root becomes dark or nearly black, and is said to lose strength.	Root collected at the improper season substituted.	Good.
82	Colocynth	do	Western Asia and Northern Africa.		The fruits of other cucurbitacean plants (*Cucumis trigonus*, Roxb., and *C. Hardwicky*) have been mistaken and substituted.	Good.
83	Conium	Both	Europe; naturalized in some portions of United States, and also cultivated.	The leaves are very liable to deteriorate by age and exposure.	The leaves of *Aethusa cynapium*, L., *Anthriscus sylvestris*, Hoffm., and different species of *Chærophyllum*, have now and then been substituted.	Variable, owing to careless keeping and age.
84	Copaiba	Imported	Tropical South America.	Varies according to age of trees and care in collection. By collectors often placed in unclean vessels.	Extremely liable to adulteration. Fixed oils, turpentine, resin, volatile oils, gurjun balsam.	Good quality obtainable from respectable dealers; but "cheap" buyers are served accordingly by unscrupulous dealers.
85	Creasotum	do	England and Germany	Liable to become browned by age, owing to insufficient purification.	Much of the commercial creasote is not obtained from wood, but from coal-tar (*Cresylic acid*). Guaiacol also substituted with carbolic acid. Tar oil and fixed oils have been used as adulterants.	Very little true, beech tar creasote in commerce.
86	Crocus	Both	Principally in Spain and France; also Austria. Sparingly cultivated in Pennsylvania.	Variable quantities of the style are often admixed with the stigmas.	Inferior saffron rendered slightly with fixed oil, chalk, sulphate of baryta, and honey to increase weight. Calendula florets, cut pomegranate petals, florets of *Arnica montana*, colored fibers of smoked beef; dried, oiled, and dyed germs of certain graminacea. Partially extracted by alcohol.	Adulteration very common.

TABLE II.—*Showing the causes of inferiorities in drugs and chemicals, &c.*—Continued.

No.	Drug.	Imported or domestic.	Where produced.	Causes of inferiority.		Commercial quality.
				Impurities and deteriorations.	Adulterations and substitutions.	
87	Cubeba	Imported	Java and Malabar	The stems (rachis) may accompany the fruits. By age and exposure loses volatile oil, &c.	The ripe fruits admixed with unripe. The fruits of *Cubeba canina*, *Piper nigrum*, *Myrtus pimenta*, in admixture; also the fruits of *Rhamnus catharticus*. Undue proportion of stems. The latter also used to adulterate the powder.	Variable; often contain a large proportion of stems.
88	Cuminum	...do	Africa, Asia, Europe (Mogador, Malta, Sicily).	Prone to attack of insects, which eat the entire seed, leaving only the fruit shell.	....	
89	Curcuma	...do	India	....	The powder is adulterated very frequently with farinaceous substances, such as pea-meal, &c.	The powder rarely of reliable quality.
90	Cydonium	Both	Europe, India, Cape of Good Hope, and United States.	Liable to become moldy; insufficiently cleaned.	Apple, pear, and grape seeds. The shells of a fruit, brown or colored brown, to the amount of 50 per cent.	Variable; often unclean.
91	Cypripedium	Domestic	United States	Extraneous matter; portion of stem and leaves.	The rhizome of *Hydrastis canadensis* not unfrequently in admixture.	Fair.
92	Digitalis	Imported	Europe	Liable to mustiness and other changes on exposure.	The leaves of the first-year's growth substituted. The leaves of *Digitalis ochrolenca*, of species of *Verbascum*, *Conyza squarrosa*, *Symphytum officinale*, *Inula helenium*, have been substituted, probably ignorantly.	Fair.
93	Dulcamara	...do	...do	....	The cut stems of *Lonicera caprifolium*, *L. periclymenum*, and *Humulus lupulus*, substituted or admixed.	Fair.
94	Elaterium	...do	Southern Europe, Persia. Cultivated in England, France, and Germany.	Varies considerably according to source or method of preparation.	Inferior qualities sold for preferred kinds.	Variable, but a good article can be had under certain brands.
95	Ergota	...do	Europe	Deteriorates by keeping, particularly if in powder; becomes quite rancid. Liable to attack of mites.	The ergot of other gramineæ, as barley, oats, &c., sometimes substituted or admixed.	Fair, but liable to vary according to age or care in keeping.
96	Ferri et quinia citras	Both	United States and Europe.	....	Has frequently been found deficient in quinia, other cinchona alkaloids substituted for quinia.	Not difficult to obtain a properly prepared article from respectable manufacturers; but "cheap" buyers can also be suited by unscrupulous manufacturers and dealers.
97	Ferri ferrocyanide	Domestic	United States	Varies according to purpose for which it is made, and consequent care.	Silica, sulphate of barium, alumina, zinc, &c.	Medicinally pure article readily obtained; but ordinary commercial article not unfrequently dispensed.
98	Ferri lactas	Both	United States and Europe.	By insufficient purification may contain casein and other organic impurities.	Calcium salts of organic and inorganic acids; gum, dextrin, milk sugar, &c.	Fair.
99	Ferri thorphas	Domestic	United States	May be insufficiently washed. Oxidized by exposure. Copper and arsenic are accidental impurities.	....	Fair.
100	Ferri subcarbon	...do	...do	Sulphate of sodium and other impurities from incomplete washing.	Variable, according to care in manufacture.	Fair.
101	Ferri sulphas	...do	United States	Prone to oxidation and efflorescence.	Impure salt sold for the pure ...	No difficulty to obtain a good article.
102	Ferrum redact	Both	United States and Europe.	Liable to become oxidized by exposure.	Adulterated sometimes with carbon. Damaged article sold for good. Powdered iron sometimes sold for that obtained by reduction.	Variable.
103	Filix mass	Imported	Europe	Very soon loses its activity on exposure. Sometimes collected at the wrong season.	The rhizomes of other species of *Aspidium* have been noticed as substitutes; but, if fresh, probably do not differ medicinally.	Owing to the liability of this drug to deteriorate the oleoresin is more generally imported, and may be obtained of good quality generally. It is sometimes adulterated with castor oil.
104	Fœnum Græcum	...do	Western Asia, India, East and North Africa, and Southern Europe.	Liable to become wormy	Powder often adulterated with farinaceous substances.	Fair.
105	Frangula bark	...do	Europe, North Africa, and Siberia.	....	The barks of *Prunus*, *Padus*, and *Alnus glutinosa* have been substituted for frangula bark.	Good.
106	Galanga	...do	China	Varies according to selection	The "greater galangal" (*Alpinia galanga*) is occasionally sold for the officinal drug. "False galangal" is also occasionally admixed. The roots of *Cypri longi* and *C. rotundi* are known as substitutes.	Fair.
107	Galbanum	...do	Persia	Extraneous impurities; sometimes very dark.	Sand, saw-dust, and impurities in undue quantity.	Fair.
108	Gambogia	...do	Siam, Cochin China, and Cambodia.	Liable to vary in quality	Adulterated in Cambodia with rice flour, sand, and the pulverized bark of the tree.	Good.
109	Gentiana	...do	Southern and Central Europe.	Liable to become musty	The roots of other species of *Gentiana* sometimes collected, but have the same medicinal properties.	Good.
110	Glycerina	Both	United States and Europe.	Coloring matter, saline compound, water, &c., from incomplete purification.	Glucose, mucilage, cane sugar ..	Very good.

TABLE II.—*Showing the causes of inferiorities in drugs and chemicals, &c.*—Continued.

No.	Drug.	Imported or domestic.	Where produced.	Causes of inferiority.		Commercial quality.
				Impurities and deteriorations.	Adulterations and substitutions.	
111	Granati radix cortex	Imported	Cultivated in Southern Europe and subtropical countries generally.	....	The bark of the stems and branches substituted for that of the root. Barberry, boxwood, and mulberry bark are mentioned as adulterants.	Good.
112	Guaiaci resin	....do	West India and Northern South America.	Extraneous matter, pieces of bark, &c., introduced during collection.	Colophony; extraneous substances added to increase weight.	Good
113	Helleboris (nigra)	....do	Europe	....	The rhizomes and roots of other ranunculaceous plants, particularly Actæa spicata, are admixed with black hellebore.	Good.
114	Humulus	....	United States and Canada.	Soon deteriorates on exposure and by keeping.	Lupulin removed. Old hops restored in color by sulphurous acid.	Good.
115	Hydrarg. chlorid. corrosive.	Both	United States and Europe.	According to care in selection of material and in manufacture, may contain fixed impurities and calomel. Arsenic has been known as contaminant from this source.	....	Good.
116	Hydrarg. chlorid. mite	... do	......do	May contain fixed impurities and corrosive sublimate when carelessly prepared.	....	Good.
117	Hydrarg. iodid. rubr.	....do	......do	By insufficient washing may contain traces of palarium or mercuric salt, according to the preponderance of one or the other in preparation.	Red lead, vermillion, and other added impurities have been noticed.	Good.
118	Hydrarg. iodid. virid.	....do	......do	May contain biniodide from careless preparation.	....	Good.
119	Hydrarg. oxid. rubr.	Domestic	United States	Undecomposed nitrate from insufficient heating.	Non-volatile compounds. Oxide of lead.	Good.
120	Hydrarg. ammon	....do	......do	Fixed impurities accidentally introduced from materials used in preparation.	Fixed adulterants such as zinc, calcium, and other salts. Starch.	Good.
121	Hyoscyamus	Imported	Europe	Soon deteriorates on keeping	The leaves of other species of *Hyoscyamus* sometimes substituted.	Fair.
122	Iodinium	Both	United States and Europe.	Moisture in crude, rarely in resublimed, in which impurities are trifling.	Graphite, charcoal, sawdust, metallic compounds of various kinds in crude iodine; moisture.	Good.
123	Ipecacuanha	Imported	Brazil, New Granada, Bolivia.	Extraneous portions of the plant	Other South American emetic roots substituted and used as adulterants, such as striated, small striated, undulated or farinaceous, white ligneous, bastard, and Indian ipecacuanha, all of which are totally different from the true root.	Fair.
124	Iris Florentina	....do	Mediterranean countries.	Liable to be attacked by insects.	The rhizomes of other species sometimes substituted. The powder adulterated with farinaceous matter.	Good.
125	Jalapa	....do	Mexico	Varies very much in quality according to season and care in collection and selection.	The tubers of other *Ipomœas*, of *Mirabilis jalapa*, &c., are often substituted and mixed with the tubers of the true jalap. Also radix mechoacannæ.	Fair.
126	Juniperus	Both	United States and Europe.	Liable to deteriorate; shrinking and losing volatile oil. Extraneous impurities are small stones, &c.	Admixed with unripe fruits, stones, &c.	Fair.
127	Kino	Imported	India	Varies according to care in collection and preparation.	Inferior grades substituted for the better.	Good
128	Krameria	....do	South America	Varies according to selection, thick, woody roots being deficient in strength. Exposure to dampness, or age, readily causes deterioration.	Substituted by the roots of other species of krameria, having, however, the same general properties.	Fair.
129	Labdanum	... do	Levant	Impurities of various kinds introduced by crude method of collection and insufficient straining.	Sand, other resins, used as adulterants. Has been altogether artificially made.	
130	Lactucarium	....do	Europe	Quality varies according to care and method of preparation.	Extract sold for lactucarium	Good lactucarium readily obtained.
131	Linum	Both	United States, Europe, India.	Often contains much chaff. Ground seed liable to become rancid.	The ground seed is often adulterated with cake meal or substituted completely by such.	Readily obtained good, but not always clean.
132	Lupulin	Domestic	United States	Rapidly deteriorates on exposure. May contain sand, and portions of the hop strobiles.	Sometimes contains considerable quantities of sand and other extraneous substances.	Fair.
133	Lycopodium	Imported	Central Europe	Often insufficiently sifted, and contains extraneous portions of the plant.	Substituted by pine pollen. Adulterated with sporules of allied species of lycopodium, talc, gypsum, resin, dextrin, starch, sulphur.	Good.
134	Manganese oxide	....do	Europe	Varies according to selection; extraneous matter such as wood, &c.	Inferior grades sold for those of higher commercial value. Adulterated or even entirely substituted by black sulphuret of antimony.	Variable.
135	Manna	....do	Mediterranean countries.	Variable according to care in collection, season, &c.	Bread crumbs, starch, glucose, flour, honey, used as adulterants. Flake manna sometimes made artificially with manna, flour, honey, and a purgative powder, molded into flakes, or purified sorts manna so molded.	Good according to commercial grade.
136	Maranta	Both	West Indies and United States.	Liable to become musty, or to acquire odor from drugs placed near it.	Other starches substituted for it.	Pure Bermuda arrowroot readily obtained from respectable dealers.

TABLE II.—*Showing the causes of inferiorities in drugs and chemicals, &c.*—Continued.

No.	Drug.	Imported or domestic.	Where produced.	Causes of inferiority.		Commercial quality.
				Impurities and deteriorations.	Adulterations and substitutions.	
137	Malico	Imported	Mexico, Central and South America.		The leaves of other plants, locally also called mali.o, such as *Eupatorium glutinosus*, *Waltheria glomerata*, *Artanthe lanceæfolia*, *A. adunca*, *Salvia sclarea*, have been substituted.	Good.
138	Mel	Both	United States and West Indies.	West India honey contains much extraneous matter, and requires straining.	Starchy substances; glucose prepared from grain. Sometimes entirely artificial.	Good honey is always obtainable from respectable dealers.
139	Melisa	do	Southern Europe; cultivated in United States.	Liable to lose volatile oil by age and exposure.	The leaves of *Nepeta cataria*, L., var. B *citriodora*, have been at times substituted.	Good.
140	Mezereum	Imported	Europe	Liable to injury by exposure to dampness and by age.	The barks of other species of *Daphne* have been at times substituted	Gopd.
141	Monarda	Domestic	United States	Liable to lose volatile oil by exposure.	Wild basil (*Pycnanthemum incanum*, Mich.), sometimes substituted in Pennsylvania.	Good.
142	Morphia and salts	Both	United States and Europe.		Morphia salts have at times been subject to the grossest adulterations and substitution by other saline compounds that are similar in appearance, such as quinine, &c.	No difficulty to get perfectly reliable morphia salts.
143	Moschus	Imported	Central Asia		Musk in grains is often adulterated and even entirely substituted by foreign substances simply flavored. The bags are sometimes deprived of part or their entire contents and other substances introduced.	Good musk can be obtained without difficulty; but careless or ignorant buyers may purchase inferior or artificial musk, there being all kinds of the latter in the market.
144	Myristica	do	India, West Indies, and South America.	Both nutmegs and mace vary according to selection, age, and care in preservation.	"False nutmegs," from myristica fatua, are substituted. The seeds of *Torreya californica*, Torr., known as "California nutmeg," are mentioned as a substitute.	Good, according to commercial grade.
145	Myrrha	do	Arabia and Eastern Africa.	Varies according to commercial grade and source. By age becomes dry and inferior, losing volatile oil. Impurities of an extraneous nature—sand, bark, stone.	Undue quantities of extraneous impurity. Gum arabic, cherry gum, a brown gum called "gummi brasiliense," bdellium, used as adulterants.	Fair.
146	Ol. amygd. amar	do	Europe	By age deposits benzoic acid, and becomes inferior.	Nitrobenzol, alcohol, chloroform; other volatile oils.	Fair.
147	Ol. amygd. express	do	do	Liable to become rancid	Cheaper fixed oils as adulterants and substitutes.	Good.
148	Ol. anisi	do	do		True anise oil substituted by the oil of star anise Both adulterated with alcohol, camphor, wax, spermaceti, stearoptene of Russian fennel oil.	The oil of star anise generally used. No difficulty to obtain either oil of good quality.
149	Ol. bergami	do	Southern Italy	Slowly acquires a terebinthinate odor.	Oil of turpentine, oil of orange, alcohol, used as adulterants.	Fair.
150	Oleum cajaputi	do	India	Liable to change by exposure	Oil of turpentine and other volatile oils.	Good.
151	Ol. carui	do	Europe	Very liable to change by oxidation, acquiring an unpleasant terebinthinate odor.	An inferior oil, obtained from the chaff of the fruit is mixed with or entirely substituted for the true oil. Oil of turpentine.	Very indifferent in the general market, though good, pure oil is readily obtained in the larger markets.
152	Ol. caryophyll	Both	United States and Europe.	Darkens by age and exposure	Chloroform, castor oil, alcohol, carbolic acid.	Good.
153	Ol. cinnamom (ol. cassiæ).	Imported	True cinnamon oil from Ceylon; cassia oil from China and East India.	Slowly deteriorates by age. Resinifies.	Both the true cinnamon and the cassia oil adulterated with cheaper volatile oils, fixed oils, alcohol, and chloroform.	Very little true cinnamon oil is used, cassia oil being in general demand and readily obtained of good quality.
154	Oleum copaibæ	Both	United States and Europe.	Thickens and deteriorates by age and exposure.	Oil of turpentine, alcohol, copaiba.	Good.
155	Ol. coriandri	Imported	Mainly if not exclusively in Europe.	Very prone to change by age and exposure.	Oil of orange; oil of turpentine	Variable.
156	Ol. fœniculi	do	Europe	Very prone to change, acquiring a terebinthinate odor.	Cheaper volatile oils	Variable, on account of readily changing.
157	Ol. gaultherea	Domestic	United States		Mixtures of alcohol and chloroform. Oil of sassafras-bark—introduced by distilling wintergreen and sassafras bark together.	Good.
158	Ol. juniperi (berries)	Imported	Europe	Very soon acquires a terebinthinate odor.	Oil of juniper wood; oil of turpentine; alcohol.	Indifferent.
159	Ol. lavendulæ	do	do	Very prone to change on exposure.	Frequently adulterated with oil of turpentine. The oil of the entire plant sold for that of the flowering tops.	Very often inferior in the market. Sold by grades.
160	Ol. limonis	do	Southern France and Italy.	Very liable to acquire a terebinthinate odor on exposure.	Other oils of the citrus family, alcohol, oil of turpentine, petroleum oils.	Variable, probably on account of ready change.
161	Ol. menth. piper	Both	United States, England, and other parts of Europe.	Readily oxidized by exposure. Varies very much according to care taken in cultivating and collecting herb.	The oils of erigeron, pennyroyal, turpentine, eucalyptus, and sassafras; alcohol, castor oil.	Good to variable.
162	Ol. morrhuæ	do	United States; Norway.	By exposure acquires a very unpleasant odor, and becomes thick. According to care in preparation also it has more or less color and odor.	Cheaper fish oils. Rape and other vegetable oils, resin, &c.	Good.
163	Ol. myristicæ, expressum.	Imported	East India	Variable according to manner and care in preparation.	Tallow and other fats, flavored with the residues from the preparation of the volatile oil of nutmeg, substituted; also the expressed oils of *Myristica fatua*, *Otoba officinalis*, &c.	Fair.

TABLE II.—*Showing the causes of inferiorities in drugs and chemicals, &c.*—Continued.

No.	Drug.	Imported or domestic.	Where produced.	Causes of inferiority.		Commercial quality.
				Impurities and deteriorations.	Adulterations and substitutions.	
164	Ol. olivæ	Imported	Italy, France, and other countries bordering on the Mediterranean.	Varies according to grade. Very liable to become rancid.	Very frequently substituted and admixed with other fixed oils, both at home and abroad. Oil of benne, groundnut, cotton-seed, purified petroleum oils, &c.	Good oil is obtainable, b the market is, general speaking, very unsatisfa tory.
165	Ol. origani	do	Europe	Prone to change by exposure	Oil of red thyme, sold almost exclusively for oil of origanum vulgare.	Indifferent.
166	Ol. rosæ	do	Rumelia		Largely and almost uniformly adulterated in Turkey with the volatile oil of *Andropogon schoenanthus*, imported from India for this purpose. Fixed oils, paraffin, spermaceti, volatile oils having the odor of rose, used as adulterants.	Variable.
167	Ol. sinapis	do	Europe		Rectified petroleum, bisulphite of carbon, pure carbolic acid, alcohol, oil of cloves, oil of sassafras, and oil of wintergreen. Artificial oil, chemically, however, identical with that produced naturally.	Pure oil is obtainable withou difficulty.
168	Ol. succinium	do	Europe	Much of the commercial oil is not sufficiently purified.	Oil of turpentine, and petroleum oils.	Fair.
169	Ol. theobromal	Both	United States and Europe.	Coloring matter from insufficient purification or careless manufacture.	Wax, stearic acid, paraffin, beef tallow.	Good.
170	Ol. thymi	Imported	France		Oil deprived of its crystalline component, thymol.	Variable.
171	Oleum tiglii	do	East India. Prepared also in England from imported seeds.	Varies with the care exercised in its preparations. Becomes thick by age and exposure.	Castor oil, sesame oil, and olive oil, as adulterants. The oil of the seeds of other species of *Croton*, probably also the oil of the seeds of *Curcas purgans* substituted.	Fair.
172	Olibanum	do	India, Arabia, and Eastern Africa.		Often inferior, deep in color, opaque, and more or less mixed with fragments of bark and other extraneous matter.	Good.
173	Opium	do	Egypt and Asia Minor.	Varies naturally in its morphia strength.	Excessive quantities of vegetable tissues; aqueous extract of the poppy plant; various kinds of resinous, saccharine, mucilaginous, and amylaceous substances; earthy and other inorganic matter; pebbles, shot, lead. Partially extracted.	Good from respectable dea ers.
174	Pareira	do	West Indies; Brazil		Stem admixed with root. The stems of *Abuta amara*, and the stems and roots of *Cissampelos Pareira*, substituted for the root of *Chondsodendron tomentosum*.	Good.
175	Pimenta	do	West Indies; Central America.	Varies according to age and selection. Liable to lose volatile oil by exposure.	Powder adulterated with farinaceous and other substances.	Good to variable, according t commercial grade.
176	Piper	do	East Indies, Philippines; West Indies.	Varies according to age, exposure, and selection. Extraneous impurities are the items.	Powder adulterated very frequently with farinaceous and other substances, such as oil cake, capsicum, &c.	Varies according to grade, bu good pepper is always ob tainable.
177	Pix Burgundia	do	Germany, Austria, and Switzerland.	By age and exposure becomes hard and brittle, owing to loss of volatile oil.	The product of other species of *Abies* substituted. Made altogether artificially—in England by melting colophony with palm oil or some other fat.	Fair.
178	Pix Canadensis	do	Canada	Becomes brittle by exposure, owing to loss of volatile oil.	A sophisticated article, made artificially with resin, oil of turpentine, &c., has been noticed.	Good.
179	Potassium bitartrate	Both	United States and Europe.	Tartrate of calcium in small quantity.	Very prone to sophistication. Gypsum, terra alba, amylaceous substances, alum, acid sulphate of sodium, &c., &c. Sometimes entirely artificial.	Variable, but from respectab dealers may generally be ob tained of good quality.
180	Potassium iodide	do	United States and Europe.	Iodate from insufficient reduction with charcoal. Chlorides, sulphates, &c., as impurities from material. Alkaline from presence of carbonated alkali.	Bromide of potassium has been substituted for iodide.	Good.
181	Prunus Virginianus	Domestic	United States	Exposure to dampness causes it soon to deteriorate.	The bark is very variable, according to care in collection, season, and care in preservation.	Fair.
182	Pulveres	do	do	The following formulas were communicated by a gentleman, formerly in the drug-grinding business, to Mr. Charles T. Carney in 1859, and, inasmuch as adulterations of powders are still practiced to a great extent in the United States as well as abroad, these may find a place here: *Powdered Cape aloes:* Cape aloes, 100 pounds; ship-biscuit, 100 pounds; curcuma, sufficient to color. *Common ginger:* African ginger, 200 pounds; capsicum hulls, 25 pounds; biscuit, 100 pounds; curcuma, to color. *Powdered ipecac:* Ipecac, 100 pounds; ship-biscuit, 25 to 40 pounds. *Powdered opium:* Turkey opium, 50 pounds; Egyptian opium, 25 pounds; biscuit 40 pounds. *Powdered gamboge:* Gamboge, 100 pounds; tartrate of lime, 25 pounds. *Cream of tartar:* Mixed with 10 to 65 per cent. terra alba or tartrate of lime, and about 3 per cent. of tartaric acid. *Tartaric acid:* Mixed with 10 to 35 per cent. of alum.		

TABLE II.—*Showing the causes of inferiorities in drugs and chemicals, &c.*—Continued.

No.	Drug.	Imported or domestic.	Where produced.	Causes of inferiority.		Commercial quality.
				Impurities and deteriorations.	Adulterations and substitutions.	
				Powdered Aleppo scammony: Virgin scammony, 30 pounds; cocoa beans, 80 pounds; biscuit, 30 pounds; lamp-black, to color. *Powdered bird pepper:* Chilies, 1,000 pounds; rice, 800 pounds; curcuma and Venetian red, to color. *Powdered fenugreek:* Fenugreek-seeds, 1,000 pounds; biscuit, 1,000 pounds; curcuma, to color. *Powdered East India rhubarb:* East India rhubarb, 100 pounds; English rhubarb, 60 pounds. *Powdered English rhubarb:* English rhubarb, 100 pounds; biscuit, 30 pounds; curcuma, to color. *Powdered Turkey rhubarb:* East India rhubarb, Turkey rhubarb, equal parts.		
183	Pyrethrum	Imported	Algeria	Very liable to the attack of insects.	The root of other species of *Anacyclus* substituted. (In Germany the root of *A. officinarum* is officinal.)	Good.
184	Quinia salts	Both	United States and Europe.	Liable to contain small proportions of the corresponding salts of the other cinchona alkaloids, particularly quinidia and cinchonidia.	Inorganic saline compounds, such as sulphate of sodium, magnesium, &c.; salicin, mannite, &c., have been used as adulterants. Cheaper alkaloids of cinchona substituted.	No difficulty to obtain pure salts of quinia.
185	Resina, jalapa, and scammony.	Domestic	United States	....	Adulterated with cheaper resins.	Good.
186	Rheum	Imported	China	Varies according to selection. Liable to attack of insects.	Inferior rhubarb rendered sightly by turmeric, or fine powdered rhubarb. Powder often made of inferior rhubarb, and rendered bright by turmeric.	Good. Select Chinese rhubarb is easily obtained at advanced prices.
187	Sago	do	East India	Fine powdery sago starch and dirt.	Much factitious sago is found in commerce, made from potato starch.	Variable.
188	Salep	do	Southern and Central Europe.	....	The tubers of *Colchicum autumnale* have been substituted. The powder adulterated with starch.	Good.
189	Santonin	do	Europe	Liable to change to photosantonic acid, becoming yellow.	Boracic acid to the amount of 50 per cent. Gum arabic in leaflets. Salicin.	Good.
190	Sapo (Castile)	do	France; Italy	....	Inferior vegetable and animal oils used in its manufacture. Large amount of water introduced. Heavy mineral matters, principally baryta, to increase weight.	Good soap, though often containing much water, readily obtained. Quality regulated by price, much inferior being in the market.
191	Sarsaparilla	do	South America and Mexico.	Varies according to source, care in collection, &c.	Inferior grades sold for the better. Substituted by the roots of *Arabia nudicaulis*, *Hemidesmus Indicus*, *Carex Arenaria*, and the climbing stems and roots of other plants.	Fair.
192	Scammonium	do	Levant	....	Chalk, flour, ashes, earthy matter, tragacanth introduced by collectors; also wax, yolk of egg, powdered scammony roots, resin, black lead. Occasionally entirely factitious.	Very variable.
193	Senega	Domestic	United States	Extraneous portions of the plant.	Ginseng, cypripedium, and other roots are now and then found in admixture, but are believed to be accidental.	Good.
194	Senna	Imported	Africa and Asia	Alexandria senna is very variable; often broken up and mixed with dust, leaf-stalks, fragments of branches, &c. Argel leaves always present.	Besides the impurities always found in Alexandria senna, all varieties of senna are liable to be admixed with the leaflets of other cassias and other leguminous plants.	Variable.
195	Serpentaria	Domestic	United States	Portions of stem, and occasionally the leaves attached.	The root of *Aristolochia reticulata* has been substituted under the name of Texan or Red River snake root. Hydrastis and spigelia have been used as adulterants.	Good.
196	Simaruba	Imported	South America	....	The bark of other simaruba barks has been substituted.	Good.
197	Sinapis	Both	United States and Europe.	Liable to deteriorate by exposure.	The seeds adulterated with those of other species of *Brassica*. The powder with farinaceous substances, pepper, capsicum, turmeric, gypsum, clay, &c.	As regards powder, very variable.
198	Sodii bicarbonas	Both	United States and Great Britain.	Liable to be deficient in carbonic acid (to be alkaline) and to contain sulphates and other impurities, from crude material used.	....	Good.
199	Sodii et potass. tartras.	do	United States and Europe.	Impurities resulting from carelessness in manufacture.	Sulphate of sodium and similar compounds.	Good.
200	Spigelia	Domestic	United States	Extraneous portions of the plant and dirt.	The roots of *Phlox carolina* have been substituted. Serpentaria, probably as accidental admixture.	Fair.
201	Spiritus ætheris comp.	do	do	Liable to become acid by age and exposure.	Substituted by a spirit often deficient both in alcohol and ether and containing no heavy oil of wine. A preparation containing light oil of wine (?), but otherwise corresponding in strength to the officinal commonly sold.	Very few manufacturers even pretend to furnish the officinal preparation.
202	Spiritus ætheris nitrosi.	do	do	Liable to acquire strongly acid properties, owing to ready change of nitrous ether and aldehyde contained in the preparation.	Often deficient in ether as well as alcohol.	Very indifferent.

TABLE II.—*Showing the causes of inferiorities in drugs and chemicals, &c.*—Continued.

No.	Drug.	Imported or domestic.	Where produced.	Causes of inferiority.		Commercial quality.
				Impurities and deteriorations.	Adulterations and substitutions.	
203	Styrax	Imported	Asia Minor	Liable to lose volatile components by exposure. Contains extraneous impurities.	Sand, ashes, and other substances mixed with it; turpentine.	Fair.
204	Sulphur, precipitate	Both	United States and Europe.	When insufficiently washed and dried liable to become acid.	Gypsum in large proportion by following a peculiar method of manufacture. Flour, starch, &c., have been noticed.	Good.
205	Tapioca	Imported	South America		Factitious tapioca made with other starches.	Commercial tapioca often factitious.
206	Taraxacum	Both	Europe and United States.	Varies according to season of collection. Liable to attack of insects, particularly when not properly dried.	Chicory roots and the roots of *Leontodon hispidus* substituted.	Fair.
207	Terebinthina Canadensis.	Imported	Canada	Liable to lose volatile oil and to become thick or solid on exposure.	Substituted by the oleoresins of other coniferous trees. "Oregon balsam," a factitious article, substituted.	Good.
208	Uva ursi	Domestic	United States	Stems and other extraneous matter.	The leaves of *Vaccinium vitis-idæa*, *V. saliginosum*, *Leiophyllum buxifolium*, and *Buxus sempervirens* have been used as adulterants.	Fair to good.
209	Valeriana	Both	New England and Europe.	Varies according to locality and care of collection and preservation. Frequently dirty.	Substituted by the roots of other species of *Valeriana*; also *Asclepias vincetoxicum* and species of *Nardus*.	Fair.
210	Wintera	Imported	South America		The barks of *Canella alba* and *Cinnamodendron corticorum* have been substituted for Winter's bark.	
211	Xanthoxylum	Domestic	United States	Liable to lose strength and to deteriorate by exposure.	The bark of *Aralia spinosa* has been substituted for prickly-ash bark.	Good.
212	Zingiber	Imported	West Indies, India, and Africa.	Liable to injury by age and exposure, and differs accordingly.	Inferior ginger is artificially whitened. Powder liable to the adulterations common to all spices.	Good grades are readily obtained in the market; but much of indifferent quality is to be met with.

THE KNOWN AND PROBABLE EFFECTS OF THE USE OF INFERIOR AND ADULTERATED MEDICINES UPON PUBLIC HEALTH.

It having been shown in the preceding chapters how inferiorities in drugs and medicines may be produced, and what is the character of such inferiorities; it having, moreover, been shown that such inferiorities are as much dependent upon accident as upon design, and that for this reason they must always exist to a greater or less extent, it becomes a proper inquiry: "What is the effect of inferior drugs and medicines upon public health?"

One need not be a physician to appreciate the fact that satisfactory medication is impossible when the medicine administered is not that designed by the prescriber. It is not sufficient that the medicine should "very nearly" be that which is designed; it should "absolutely" correspond to the standard which the physician has before his mind at the time when he finds it necessary to prescribe it. It is therefore the duty of the dispenser to see to it that the medicines he dispenses conform in every respect to the standard that has been framed for his guidance as well as for the guidance of the physician. The fulfillment of these conditions depends not alone on the integrity of the dispenser, it depends equally on his knowledge and skill; and unless these are combined with integrity, the prescriber cannot hope for results which the nature of the disease may justify him to expect. Finding that the medicine has not the expected effect, the prescriber may be led to increase the dose, or to replace that originally prescribed by another, without, however, ameliorating the disease or causing it to yield to his treatment. He now, perchance, begins to suspect that the medicine supplied is not as it should be, and, changing his apothecary, soon cures his patient. If all cases of bad medication were as simple in their development as the one illustrated, there would perhaps be no necessity for this report. Unfortunately, however, such is not the case. It quite often happens that, the diagnosis being well established, it is urgent that the proper medicine should be promptly administered. If in a case of this nature the medicine should happen to be of indifferent or inferior quality, the life of the patient is placed in jeopardy, and under circumstances sacrificed. Again, the prescriber, conforming the medication to his diagnosis, may be led to reject that originally made, because he fails to obtain the effect which an abundant experience justifies him to expect fro n the drug administered. In a case of this kind, he may for a time be completely at fault while the illness of his patient is vexatiously prolonged or it may be aggravated. In short, the use of inferior and adulterated medicines may be the cause of protracted disease, of increased suffering, and in some instances of death; and failing to mitigate and cure diseases in which the pure medicine is unequivocally indicated, they may lead the physician to errors in diagnosis, cause him to acquire the habit of prescribing large doses of active medicines, and in fact seriously affect his success and reputation.

Finally, there are many medicines that are in daily demand over the counter of the druggist as household remedies, with or without the sanction of the physician. Many of these are of an innocent nature, and being used for trifling ailments, any variation in their strength is not attended with serious consequences. Others, however, are quite active agents, or contain such. This is particularly the case with preparations containing opium, for all of which commonly dispensed there exist either officinal or other authoritative formulas. It is plainly the duty of the dispenser to adhere to such authoritative formulas, whether officinal or not; but from motives of gain and competition the preparations of some shops contain variable quantities of opium, often one-half or lesss of that which is proper, and this is true equally of the more powerful ones and of the weaker preparations intended for the infant. Naturally the dose of such a weak preparation is increased until the desired effect is obtained, and all works well until the supply is replenished by some conscientious dealer, when, as is unavoidable, an overdose is the result, attended with more or less serious consequences.

In the foregoing chapters the writer has pointed out the conditions of inferiority in drugs and medicines, how these conditions are created, and what some of their influences may be upon public health. It naturally follows that we should also inquire into

THE MODES WHEREBY THESE CONDITIONS MAY BE PREVENTED OR MODIFIED.

Inferiorities in drugs and medicines being brought about both by accident and design, it must be evident that measures of prevention or amelioration that will reach one kind of causes of inferiority need not necessarily reach the other. To reach the one, wise legislative enactments appear to be called for, while the other can only be reached through the medium of education. Let us consider:

1. *What may be accomplished by legislative enactments.*—When speaking of the influences that have shaped the present condition of the drug market, it was shown that however imperfect the drug law might be, its influence for the better was soon felt, and that it has continued to the present day to exercise a wholesome effect in preventing the introduction of inferior or adulterated drugs and medicines from abroad. On the other hand, it was contended that the law itself was far from perfect; that owing to the system of political appointment, it was at times very imperfectly administered; and that at the present day inferior and falsified goods are occasionally admitted from abroad. Now, if we admit this to be a truthful statement of facts, it must become plain that if we remove the existing imperfections in the law, if we uniformly secure the services of officers of high integrity and qualifications, and if we furnish these officers with ample means and authority to carry out the law, it is quite possible to secure the complete exclusion of inferior drugs and medicines from abroad, and thus to remove one fruitful source of bad medicines. What some of the faults of the present law are has already been pointed out, and others might be mentioned; but their further discussion would extend this report beyond proper limits,

It has been elsewhere pointed out how the American Pharmaceutical Association exerted a powerful influence in shaping the present favorable condition of the drug market. It has accomplished this solely by its untiring efforts to impart and disseminate knowledge, and by its tendency to elevate the professional character and standing of pharmacists. When that association was first organized, there existed only a few colleges of pharmacy and only a single local association outside of these colleges. At the present day there are some twelve or more colleges of pharmacy where young pharmacists may acquire the theoretical training so necessary to their profession. State pharmaceutical associations have also been organized in many of the States of our Union, while in most of the larger cities associations of the alumni of the colleges of pharmacy have been formed. Most of these institutions and associations owe their origin indirectly to the American Pharmaceutical Association, and their beneficent influences upon the condition of pharmacy in this country cannot be overestimated, inasmuch as it is believed that to moral and educational rather than to legislative and compulsory modes we must largely look for the amelioration of conditions of inferiority brought about in dispensing establishments.

It does not follow, however, that on this account legislative measures should be neglected. To the contrary, the influence of law may be properly brought to bear so as to compel dispensers of medicine to acquire the knowledge that is necessary to the safety of the public. To this end much has already been done, but much more is required; and it is proper to state that in this direction also the pharmacists themselves, again through the medium of the American Pharmaceutical Association, have taken the initiative by urging upon the legislatures of the different States the necessity of restricting the compounding and dispensing of medicines upon the prescription of physicians, to persons who have suitably qualified themselves for their responsible vocation. In 1869 the draught of such a law (see appendix) was submitted to the governors, presiding officers of legislatures, and leading judges of all the States, with a view to drawing attention to the necessity of a law as well as to secure uniformity of action throughout the United States. Previous to that time laws on pharmacy existed only in two States—in Georgia and in Alabama—but these were long allowed to be dead-letters. Since then laws have been enacted in many States,* all of which conform in some degree to that drafted by the American Pharmaceutical Association, but are more or less imperfect, either by being restricted in their application to cities having a certain number of inhabitants or by other deviations from the original draught, found necessary, unfortunately, to secure their passage.

Educational influences should not alone be brought to bear upon the pharmacist; they must also be brought to bear upon the general public; not that it is at all necessary that the public should have an intimate knowledge of remedial agents—though there is no objection provided such knowledge is positive and not, as is too frequently the case, empirical—but the public should be led to recognize that the business of the pharmacist is largely professional in its character; that he constantly sacrifices both time and money's worth in order to keep his stock of medicines in a suitable condition for successful medication; that he must keep in stock a large variety of medicines—often very expensive, but seldom demanded or readily deteriorating—so that he may promptly and at all times meet the demands of prescribers; that he is obliged to be in readiness at all hours, day or night, to respond to such demands; that his returns are rarely commensurate with the sacrifices of time as well as of comfort that he is obliged to make, and that therefore his charges cannot be regulated by the rules that ordinarily govern trade.

Finally, the relation of the medical profession to that of pharmacy in this country is not as satisfactory as it should be, and must to a certain extent be held responsible for the unsatisfactory conditions under discussion. The pharmacist occupies a very peculiar position. Being both a tradesman and a professionalist, he unites in his dual calling opposing interests. As a tradesman, it is his sole aim to make money; as a professionalist, it is his aim to guard the interests of the public by supplying medicines of pure quality, without regard to cost or trouble. If he succeeds in uniting these diverging interests, then both the public and the pharmacist are the gainer; but if he fails in this, the one or the other must necessarily suffer. The physician is purely a professionalist. It is his aim, if he deserves that title, to ameliorate and cure disease without regard to the material recompense that may follow; and to this end, it is his duty to draw into requisition the best agents that knowledge and science may point out to him. But does the physician always do this? Is he careful to inform himself so that he may be able to judge the quality of the medicine that may be furnished on his prescription? Is he not in duty bound to prescribe only such medicines the characters of which are or may be well established? Is he justified in prescribing "special" remedies, the exact composition of which is wholly or in part withheld? Is it not his duty so to formulate his prescriptions that it is possible for any practical pharmacist to compound the same from among the recognized drugs, chemicals, and preparations that may be found in all well regulated pharmacies? Is it not also his duty to encourage the pharmacist to prepare all medicines, the characters of which are such as to make it difficult to establish any variation from the standard that may exist, and however slight such may be? Does he not, by the pernicious practice of prescribing the preparations of specified manufacturers, which practice has increased to such an extent as to be an abuse, bring about the very conditions that are so largely instrumental in introducing inferior medicines, by causing the dispenser of medicines to overstock his shop with preparations that are liable to deterioration; by restricting his field of observation in the preparation of medicines; by tempting him to substitute the preparation of one manufacturer, which is in stock, for that of another which it is difficult or unprofitable to procure; by making him indifferent to the professional duties of his calling, when those of the tradesman are so constantly in requisition, and his skill and knowledge count for nothing.

This report would be incomplete if a short chapter were not devoted to so-called

PATENT MEDICINES.

Statisticians, as well as other competent authorities, have shown that more secret remedies, so-called "patent medicines," are prepared, sold, and consumed in the United States than in any other country. The trade lists of these preparations embrace a much larger number of articles than the list of medicines embraced by our pharmacopœia, and their consumption is at least equal to, if not, as is contended by some, larger than that of legitimate medicines. It is useless to argue with the public that the pernicious effects of this class of medicines far outweigh their good effects; that cures are very rarely effected by their use, and that such are purely accidental; that their popular estimation is based altogether on temporary or imaginary relief; and that being on this account recommended and resorted to in every emergency, they are far more likely to do much mischief than to do a little good. It is difficult for the public to understand that the manifestations of pain or discomfort observed in illness are only symptoms of the disease, and that such symptoms, though to the uninitiated apparently identical, may point to entirely distinct diseases; and that, therefore, the remedy that is indicated for the one may be entirely unsuited, or, as is often true, hurtful in the other. The public, furthermore, fail to appreciate the fact that in this class of medicines often lurks a far greater evil than that which they are expected to cure or alleviate. The most energetic agents of the materia medica are known to enter into their composition often in quantities that a physician would hesitate to prescribe; such being necessary to produce the decided and prompt manifestation of effect upon which their sale and popularity so largely depends. Narcotics or stimulants are largely represented in them, and it is easy to understand, not only how in a large class of diseases, real or imaginary, temporary relief may be obtained; but, also, how such may be the direct cause of habits, the ultimate consequences of which are moral and mental ruin and death.

The subject of "patent medicines," in its bearings upon public health, has so frequently been discussed by writers of note, in both the medical and pharmaceutical journals, that very little further light can be thrown upon the subject now. That their indiscriminate sale and consumption has brought about many and serious evils, and that therefore it is necessary to bring into force some controlling influence whereby these evils may be modified and ameliorated, is admitted by all who have given their attention to this subject. It is by no means clear, however, how this desirable sanitary measure may be accomplished. Among the different plans that have been proposed, a modification of that requiring the publication of the formulas of "patent medicines" upon the label, strikes the writer as best calculated to modify the evil effects resulting from their use. Indeed, a United States law bearing upon this subject is not only desirable but necessary, if it is aimed to carry out effectually the following article* pertaining to the existing drug law:

"Patent and secret medicines are by law subject to the same examination as other medicinal preparations, and cannot be permitted to pass the custom-house for consumption, but must be rejected and condemned unless the special examiner be satisfied after due investigation that they are fit and safe to be used for medicinal purposes."

How is the special examiner, however, to determine the fitness and safety for medicinal use of such a preparation, unless he has some standard to guide him? It is true, he can by analysis determine the presence of active medicinal agents, quantitatively as well as qualitatively; but the presence of such, whether in large or small proportion, need not necessarily debar it from entry. If, on the other hand, the quality as well as the quantity of active

*Pharmacy laws are now in force in the following States: Rhode Island (1870 and 1871), applying to the whole State; Maryland (1870 and 1872), applying to the city of Baltimore; New York (1871 and 1872), applying to the city of New York; Pennsylvania (1872), applying to the city of Philadelphia; California (1872), applying to San Francisco County; Ohio (1873), applying to cities of 175,000 inhabitants; Missouri (1874), applying to the city of Saint Louis; Kentucky (1874), applying to towns and cities of 5,000 or more inhabitants; New Hampshire (1875), applying to the whole State; South Carolina (1876), applying to the whole State; Maine (1877), applying to the whole State, and New Jersey (1877), applying to the whole State. For the District of Columbia, also, a law was passed by Congress within the past few years.

*Art. 256 (Sec. X) of the "General Regulations under the Revenue and Collection Laws of the United States," 1857, p 158.

medicinal agents allowable in such medicines were plainly defined, a standard would be established whereby special examiners might regulate their action.

To reach this class of "patent medicines," as well as those that are prepared in this country, both a United States and State laws are probably necessary. However that may be, a law to be effectual must be general in its application, and, if such can be had, the following modification of the plan requiring the publication of the formula upon the label is perhaps the most just, both to the manufacturer and the consumer:

1. Designate by law what substances shall be regarded as "active" medicinal agents.

2. Designate the extreme quantity of such active medicinal agents that may be contained in a given quantity of a "patent medicine," both with reference to its being the sole active component and to its being combined with other active agents possessing similar physiological action.

3. Require all "patent medicines," whether of foreign or domestic manufacture, to be registered by their full title at some suitable office under the control of the general government, requiring also that the uses to which such medicines are to be applied, and the doses in which they are recommended to be given, be placed on record.

4. In the event that such a "patent medicine" contains one or more medicinal agents classed as "active" within the meaning of the law, require the manufacturer to deposit at the registering office information of the exact quantities of such that are represented by a given quantity of the preparation.

5. Require under all circumstances that the minimum and maximum doses of the "patent medicines" be distinctly printed on the label; and if it contains one or more of the "active" medicinal agents designated as such by law, that their presence be unequivocally given upon the same label; not, however, requiring that their quantity or proportion be stated upon such.

A law of this character would enable governments, the medical profession, as well as the consumer, to form in some degree a judgment of the character and probable effect of a "patent medicine," and would greatly tend towards ameliorating and preventing the evil effects observed under existing conditions. And if in addition to such a law the public can be brought to place greater reliance upon legitimate medicine and less upon the professions of charlatans and mountebanks—if, moreover, a better relation between the public, the pharmacist, and the physician can be established—the use of "patent medicines" will ever be confined to the classes among which such will always find favor—the low and the ignorant.

APPENDIX.

A.

Fragmentary list of drugs rejected at the different custom-houses since 1848, *as communicated to the American Pharmaceutical Association at various periods.*

Drug.	New York.				Baltimore.	Boston.	
	1849–1852.	1853.	1873.	1874.	1853–1856.	1848–1852.	1867.
Aloes	12,375 pounds	246 pounds					
Althæa root	1,117 pounds			1 bale			
Assafœtida	3,700 pounds						
Belladonna leaves			11 bales				
Benzoin		860 pounds					
Bistort root	140 pounds						
Blue pill				1 case			
Bromine	430 ounces						
Buchu leaves			1 bale				
Buckthorn bark				1 bale			
Calamus root			1 barrel				
Cantharides	1,276 pounds						
Cardui Benedict			1 bale				
Chamomile flowers	1,896 pounds		2 casks				
Colchicum root			1 bale				
Colchicum seed	2,246 pounds						
Conium leaves			5 bales				
Cream of tartar	7,673 pounds						
Creasote	140 ounces						
Cubeb *stalks*							3,600 pounds.
Dandelion root			6 bales				
Elder flowers			1 bale				
Ergot	475 pounds						
Gamboge						189 pounds	
Gentian root	7,572 pounds						
Gentian-root powder	430 pounds						
Gold thread							300 pounds.
Guaiacum resin	9,300 pounds	1,130 pounds	25 barrels	2 cases, 5 barrels			
Hellebore root	460 pounds		1 bale				
Herbs and flowers					465 pounds		
Hyoscyamus leaves			7 bales				
Iodide potassium	3,720 ounces						
Iodine	6,864 ounces						
Jalap root	37,121 pounds			201 bales			
Kino	230 pounds		1 case				
Lavender flowers	3,042 pounds						
Licorice root	9,430 pounds						
Magnesia, calcined	1,560 pounds	875 pounds					
Magnesia, carbonate	2,867 pounds	3,900 pounds					
Manna		720 pounds					
Mezereon bark	1,353 pounds		1 bale				
Myrrh		837 pounds					
Opium	3,164 pounds	675 pounds	40 cases	33 cases		6,396 pounds	400 pounds.
Pareira Brava root	730 pounds						
Peruvian bark	304,135 pounds	38,459 pounds		6 bales	38,062 pounds	1,200 pounds	
Poppy flowers	190 pounds						
Quinia sulph	3,200 ounces						
Rhubarb root	5,782 pounds	610 pounds	5 cases				
Rhubarb-root powder			1 case				
Roots and seeds					367 pounds		
Saffron	360 pounds						
Sarsaparilla root	65,374 pounds	4,370 pounds					400 pounds.
Savin leaves			1 bale				
Scammony	230 pounds	495 pounds		20 pounds		2,095 pounds	1,200 pounds.
Senna leaves	31,838 pounds	11,820 pounds	3 bales			271 pounds	
Serpyllum			1 bale				
Squills	1,626 pounds	1,537 pounds	24 bales				
Sugar of lead		11,017 pounds					
Sulphur, precip		3,620 pounds					
Valerian root	650 pounds					1,839 pounds	
Viola herb			1 bale				
Volatile oils					1,928 pounds		
Wormseed	230 pounds						

NOTE.—Inquiry made at the Bureau of Statistics developed the fact that while statistical record of admitted drugs is kept no note is taken of drugs that are rejected. The above fragmentary list is, therefore, probably the only record of drugs that have been rejected at the different custom-houses since the law went into effect.

ROUGH DRAFT OF A PROPOSED LAW TO PREVENT THE ADULTERATION OF FOOD AND MEDICINE AND TO CREATE A STATE BOARD OF HEALTH.

[By E. R. SQUIBB, of Brooklyn.]

To the Medical Society of the State of New York:

The subject of a law to prevent the adulteration of food and medicine has throughout the past year been under consideration by a joint committee made up of representatives from the New York Academy of Sciences, the New York Academy of Medicine, New York County Medical Society, the Therapeutical Society, New York College of Pharmacy, New York Medico-Legal Society, the Public Health Association, and the American Chemical Society, and considerable time has been devoted to the examination of the subject, and two or three drafts of laws besides this have been prepared and submitted to discussion.

After a review of some part of the experience of Great Britain under the "Sale of Food and Drugs Act" of 1875, and a consideration of the chief difficulties it has encountered up to this time, the present writer believes that any law to be effective and of easy application must carefully avoid certain points of difficulty which have been brought out by the British law.

First. The law must so clearly define the offense of adulteration in all its various forms, even by repetition in wording the definition where this may be useful, as to make the various forms of the offense plain to the understanding of the persons who adulterate rather than by general definitions to leave too much to be decided only by litigation in the courts. If the offense be well defined to the person who adulterates, the first effect will be to prevent or deter him. Failing in this, it will make the facts establishing the offense so clear as to economize the time of the courts and law officers and leave to them to decide mainly upon the character, turpitude, and degree of the offense charged, and thus adjust and apply the penalty. Hence, in the draft of a law here presented, the defining clauses might be construed by the careful logic of a legally-trained mind as mainly repetitions of one idea. Yet, to the minds of the class of shrewd money-makers in the community to whom and to whose practices the definitions are really addressed, the looseness of a general phraseology would fail in deterring them from taking the chances of discovery and conviction. And, again, under this head and for these same reasons, the standards for comparison by which the offense is to be determined should be a part of the law, and be much more definite than by the British law.

To illustrate the utility of careful and clear definitions of various known forms of the offense as aimed at by the different defining clauses, one or two typical instances of common adulterations are given in the margin of each defining clause to show its special application.

Secondly. The questions of intent to defraud and of injury or prejudice to the purchaser of adulterated articles, either as to health or to cost, are carefully avoided, because in a definite, fully recognized shape they are entirely wanting in the adulterator, and are always difficult to prove. A very large proportion of the adulterations practiced are not attempts at fraud nor designed to damage health, but are straining efforts to make money. And these efforts are so earnest and so intense, energetic, and absorbing as to leave all other considerations in the background. That the public is hurt and cheated is often but an accident rather than a malicious intention.

In place of these the adulterator is made responsible for the effects of his acts in their more definite and physical relations to the public and to the penalties imposed upon them. The offense then consists in the act of debasement, which is so easily proven by the debased article. And a pleading of absence of intent to defraud, or of the harmless character of the debasement to the individual purchaser, would simply amount to a plea of ignorance of the effects of the offense, and would be judged by the courts, not so much on the question of conviction, because the public offense of debasement has been committed, but simply as to the extent to which the adulterator should suffer in order to prevent others from similar acts through similar ignorance.

Thirdly. The making it the duty of the consumer who may be injured to prosecute the offenses, using the inspectors merely as witnesses in the prosecutions, has been carefully avoided, because it has been found that very few persons have either the inclination, time, or money to give to such prosecutions, and that it is much cheaper for individuals to suffer than to prosecute.

Neither has it proved more effective to place the duty of prosecuting upon institutions or societies, giving them the fines or other emoluments in compensation, because in this way the work has rarely, if ever, been effectively done.

Hence, any law of this kind to be reasonably effective must embrace provisions for its own thorough and complete execution from beginning to end.

Then the organization necessary to carry into effect any such general and important law of so great necessity and so wide an application must be of exceptional and peculiar fitness; and, therefore, be very expensive, because it must consist of experts of a high order and especial training.

But just such an organization as would be necessary for such a law is now almost equally necessary for many other important objects in connection with the public health interests of every State. That this State should have been so long without such an organization, when the experience of neighboring States all around has been so unequivocal in regard to the advantages obtained, is, at least, a remarkable fact.

In consideration of this fact, it seems to this writer that no better time for the creation of a State board of health could be proposed than in connection with the enactment of a law to prevent adulterations, leaving to future laws the various other not less important duties which might be performed by a State board of health, as in the instances of Massachusetts, Michigan, and many other States.

The need for some such law as this is now so evident as to require no argument, and the advantages of State boards of health can, in view of the experience of many States, be no longer doubtful, even when no such law as this is among the duties of such boards. But whether this State would be justified in enacting so expensive a law, thereby increasing the taxes upon an already overtaxed population; that is, whether such a law would or would not be a true and wise measure of economy is not so easily seen, and requires careful thought and consideration. By a very rough estimate based on the manufacturing and mercantile interests of the State the losses to the population through practices of carelessness and adulteration, through over-competition and greed for money-making, which such a law is intended to check and finally prevent, cannot be less than seven hundred thousand dollars per annum, though probably much more. Then, assuming the population of the State at five millions (recently given as 4,995,000), the loss per capita per annum cannot be less than fourteen cents. The State board of health here contemplated would cost the State about eighty thousand dollars a year, without trusting to fines or emoluments to reimburse any part of such cost. This would add one and six-tenths cents to the taxes per capita per annum in order to try to save fourteen cents. But suppose such a board should succeed in preventing only one-fifth of the estimated losses by adulteration, or two and eight-tenths cents per capita per annum, it would still be a public economy of over eight per cent. per annum on a public debt which is neither unseen nor unfelt, though very much neglected, by the working classes who suffer most by it. If such a line of argument be admitted, it is easy to see that the enactment of such a law, with such provision for its thorough execution, would be wise and economical at any time.

Laws are effectual, and therefore of use, just in proportion to the means which they provide for their own thorough execution, and any law against such offenses as adulteration which would not have full power within itself to enforce its provisions and penalties might cost little, but would certainly be useless, and if useless would be hurtful by debasing and diluting the public respect for law.

The rough draft of a proposed law, which is herein submitted to the Medical Society of the State of New York, was drawn up for presentation to the joint committee above alluded to, and will probably be presented to that committee before it is presented to this society; but it is a matter of great interest and importance to this society, and if placed before the society's constituency throughout the State by means of the volume of Transactions, it will doubtless attract some of that attention which the importance of the subject deserves, and may assist in obtaining some such law from the legislature.

The writer has for many years past given much attention to the subject of adulterations, and has pretty carefully watched the laws that have been enacted at home and abroad to try to check and control this rapidly increasing and insidious public evil, and having become somewhat familiar with some of the very great difficulties that have been developed by the operation of the various laws, he has drawn up this draft to meet and overcome those which seemed most prominent. He has, therefore, what is believed to be a good, practical reason for every provision here asked for in such a law, and can explain the objects of the provisions, if need be, by instances of deficiency or failure in former laws. Yet, it is not pretended that this draft is anything like complete and as well drawn as it should be. Some legally-trained mind should examine analytically all the convictions and failures to convict which have occurred under the British law of 1875, and all the discussions and recommendations of the British Society of Analysts, charged with the execution of that law; and also the report of a commission of the German Empire charged with making investigations during two years past with a view to a law for Germany.

The British plan seems to have been to modify one law after another through a series of years, making each new law an improvement on the one preceding it, and a committee of Parliament is understood to be now engaged in amending the act of 1875 in view of recent rulings and decisions of the courts. If now this State could take full advantage of that prolonged experience by sending a trained expert to examine it carefully, as Germany did, a proper law might doubtless be framed that would be far more efficient than anything that could possibly come from such inexpert efforts as those of the present writer. In this country and in others much time has been lost to this subject by hasty enactments passed without full knowledge of the difficulties to be met and without full investigation of what had been already done in the way of attempts and failures or without providing effective means for enforcing the laws thus passed.

AN ACT to prevent the adulteration of food and medicine by discovering and punishing the offense, and to repeal all other acts or parts of acts in conflict therewith, and to establish a State board of health.

Whereas the public welfare is injured by the adulteration of food and medicine; and whereas the practices of adulteration are increasing, and are not easily detected by the masses of people most injured by them: Therefore,

Be it enacted by the people of the State of New York, through their representatives in the legislature—

First. That for the purposes of this law the term "food" shall include every article used for the food and drink, or in the food and drink, of man and animals.

Second. That the term "medicine" shall include every article, other than food and drink, that is used for the preservation of health or for the relief or cure of disease, in man and animals, including antiseptics and disinfectants and cosmetics.

Third. The standards by which the offense of adulteration shall be judged, or the degree in which the offense may have been committed, shall be—

For simple articles of food, a fair average quality of the substances in their natural condition; or as best prepared by drying, grinding, packing, &c., without damage from their natural condition.

For compound articles of food the publicly-known formulas, or patents, whereupon they should be compounded, or the labels or descriptions attached to the compounds as given, sold, or offered, or held in possession.

For simple articles of medicine, the standard shall be the United States Pharmacopœia for all articles embraced by that authority. For articles not so embraced, the national pharmacopœias of other countries.

And when not embraced in these, some commonly-accepted standard authority. For compounded articles of medicine, the same standards as above cited for simple articles, for all which they may embrace. For all other compound medicines the standards shall be the formula or recipe attached to the compound by label, or otherwise when given, offered or held in possession; or the physician's prescription or recipe by which it shall have been compounded; or the patent or recipe to which the name or trade-mark of the compound applies. In the case of proprietary or private compounds, the constituents of which are legally held as secrets, the testimony of the owners of the private formulas shall be accepted as evidence of the character of the compound.

Provided, That nothing herein contained shall be construed so as to protect or permit the issue of any compound which contains any poisonous or hurtful ingredients not publicly stated and professed by the label attached to the compound when given, sold, offered, or held in possession. [Examples given for illustration: alum in baking powder; lead in cosmetics; powerful drugs in patent medicines.]

Fourth. For the purposes of this law, the offense of adulteration shall be as follows:

1st. The adding of one or more substances to another or others, whereby the strength, purity, quality, or true value of the resulting substance or mixture is reduced or lowered in its nature or composition, with the effect of tending to deceive the public by lowering such substance or mixture from its original and true value, or altering the public significance and common meaning of the name by which it is, or was, originally known or used. [Corn-meal in flour; chicory, &c., in coffee; terra alba in cream of tartar; foreign substances in powdered opium.]

2d. The substitution of one substance for another, either wholly or in part, with the effect of tending to deceive or mislead the public or any part thereof. [Artificial wines or liquors and mixtures; artificial mustard; powdered colocynth-seed for colocynth.]

3d. The abstraction of any part of any substance with the effect that the separation shall reduce the value of the substance, and thus tend to deceive or mislead by changing the common significance of the name by which, as a whole, the substance was originally applied to use. [Cream from milk; partly exhausted tea, coffee, and drugs; thymol from oil of thyme.]

4th. The application of a name commonly known or understood to indicate any substance to any part or parts thereof, or to any other substance, with the effect of tending to deceive or mislead. [Oleomargarine for butter; potato starch for arrowroot; dead oil for carbolic acid.]

5th. The presence in any substance of any impurity or any foreign matter that is either natural or accidental to it, if in unusual proportion. [Dirt in all food or medicine; metallic salts in canned provisions.]

6th. The admixture of different qualities of the same substance, with the effect of tending to deception and fraud. [Damaged wheat in flour; garden rhubarb in medicinal rhubarb.]

7th. Any debasement or dilution of any substance whereby it is reduced in intrinsic value and is yet liable to be given, bought, sold, or used as though it was not debased or diluted. [Diluted milk, vinegar, liquors, and medicines.]

8th. Any coloring, coating, polishing, or powdering, or any other alteration in the physical condition or sensible properties of any substance, with or without addition to or subtraction from it, whereby damage is concealed or it is made to appear better or greater than it really is, either in quality, weight, or measure; or whereby impurities or defective quality are partially or wholly masked or hidden, with the effect of tending to deceive or mislead. [Coloring and polishing of green coffee; powdering and coloring of damaged drugs; bread from damaged or mixed flour; "large" bread of short weight.]

9th. The giving or selling, or offering for sale, or the possession of any adulterated article by any person whose business is to make or to deal in articles of food or medicine, shall be *prima-facie* evidence of the offense of adulteration.

Provided, That it be, and it is hereby declared to be, the sole and entire object and intention of this law to protect the public against deception and fraud in the cost and quality of food and medicine through adulteration. And all the provisions of this law shall be construed and applied in accordance with its sole object, by the rules of common law.

No person shall adulterate, nor cause nor permit any other person to adulterate, any article of food or medicine, under a penalty in each case not exceeding two hundred dollars' fine for the first offense. But every offense after a conviction for a first offense shall be a misdemeanor, for which, on conviction, the person shall be imprisoned with hard labor for a period not exceeding six months.

No person shall give or sell, or offer for sale, or hold under the ordinary conditions of salable commodities, any adulterated article of food or medicine, under the same penalties as in the preceding section.

No person shall give or sell, or offer for sale or hold under the ordinary conditions of salable commodities, any article of food or medicine which may have become, through natural or accidental causes, deteriorated or adulterated so as to be unfit for common use, under the same penalties as in the preceding section.

For the proper execution of this law, and for other purposes in connection with the public health, there shall be formed, within eighteen months after the passage of this law, a State board of health, to consist of five members, to be appointed as follows:

Within one week after this act becomes a law, the governor shall invite the Medical Society of the State of New York, through its president, to nominate through its nominating committee four prominent physicians, who may or may not be members of the society. He shall also invite the faculty of Columbia College through its president, and the faculty of Cornell University through its president, each to nominate one expert chemist and one physicist. He shall also invite the Bar Association of New York and the Medico-Legal Society of New York, each to nominate, by a committee raised for that purpose, one expert lawyer. From these eight nominees the governor shall select and appoint, with reference solely to their fitness for the duties involved, two physicians, one chemist and physicist, and one lawyer; and upon his own motion he shall select one business man who shall be, or shall have been, an experienced merchant or manufacturer; and these on being sworn in shall constitute the State board of health, and as such be empowered to sue and be sued and do all other acts, &c., for the due execution of the laws with which they may be charged.

In case of the failure of any or all of the bodies invited by the governor to nominate at their next succeeding regular meetings, it shall then be the duty of the governor to invite nominations or suggestions from any other competent prominent public bodies or individuals whose especial training and knowledge of the fitness of experts for such duties is likely to be found, and to select and appoint any or all the remaining members from such nominations or suggestions as, in his judgment, shall be best for the interests and welfare of the State.

Thus constituted, the governor shall call the board together and shall appoint from their number a temporary president and secretary. The board shall then organize and proceed to a consideration of its duties and of a plan for carrying out the provisions and intent of this law in detail. Then, after due deliberation, it shall elect by ballot from its own number a president of the board, to hold office during the pleasure of the board by annual elections. The board shall then select and appoint, not from its own number, a secretary, who shall, under the direction of the board or its president, perform all the duties of secretary, treasurer, and executive officer of the board.

This State board of health may, by a majority vote at any time, report to the governor of the State any changes in its membership that such majority may desire, and the governor shall proceed forthwith to make such changes in the way prescribed for the original construction of the board.

The offices of the State board of health shall be located in the city of New York, and the board shall be authorized to procure the necessary rooms, furniture, apparatus, and books, and to employ the clerks, messengers, and laborers that may be necessary. The business meetings of the board shall be held not less frequently than once a month, and three members shall constitute a quorum for the transaction of business.

As soon as the State board of health shall have completed its permanent organization and have matured its plans of operation, and within three months after its appointment, it shall, by public advertisement, issue proposals for competitive examinations, to be held by the board at such times and places as may be deemed best for obtaining subordinate officers for the board. By such competitive examinations the board shall determine the qualifications of any number of persons to execute the various provisions of this law by rules and regulations adopted by the board.

From the number of persons thus found qualified the board shall then select, constitute, and appoint a board of inspectors of food and medicine, to consist at first of not less than seven members, or one for each half million of inhabitants of the State, said number to be increased from time to time as experience in the requirements of the law may indicate. The members of this subordinate board shall hold office at the pleasure of the State board of health, and removals and vacancies of all kinds shall be filled in the way prescribed for the original construction of the board of inspectors.

The State board of health shall at the same time and in the same way select, by competitive examination, from the profession of law any number of persons qualified legally to enforce the provisions of this law. From the persons thus found qualified the board shall select, constitute, and appoint a board of prosecution for legally enforcing the provisions and intent of this law by securing punishment of the offenses committed under it. This board of prosecution under the food and medicine act shall consist at first of not less than four members; one for the western, one for the middle, and two for the eastern parts of the State, and its members shall hold office during the pleasure of the State board of health, and all vacancies in it shall be filled in the way prescribed for the original construction of the board.

The duties of the inspectors of food and medicine shall be to discover the offense of adulteration and obtain evidence thereof by systematic methods to be established by the State board of health and to serve as witnesses in the prosecution of the offenses by the prosecuting officers before the courts.

For the purpose of discovering adulterations of food and medicine, and obtaining competent evidence of the offenses, said inspectors shall each obtain and examine carefully not less than ten articles of food and medicine each week, and keep a full record of the dates, methods, and results of each examination.

Each inspector shall cause it to be publicly known in his district that he will receive, for a moderate charge, to be fixed by the State board of health, all complaints of suspected adulterations, and will investigate such complaints, if need be, by the same methods as may be directed for the examinations made on his own motion, and he shall keep a full record of all complaints, that may be made to him, and of his proceedings in each case, for presentation to the State board of health.

The board of inspectors shall hold meetings at stated times, not less frequently than semi-annually, to compare the experience of the members in their duties, and to secure *improvement and uniformity* in their methods of proceeding, and to preserve a concert of action throughout the State. And the board shall report the proceedings and its recommendations to the the State board of health. for reconsideration and action.

The board of prosecution under the food and medicine act shall hold meetings at stated times, not less frequently than semi-annually, for the same purposes as the board of inspectors, and shall report their proceedings and recommendations to the State board of health in the same way. Each member of the board of prosecution for his own district shall receive from the State board of health all cases that the State board shall order to be prosecuted, and shall prosecute all such cases in the name of the people of the State in the proper courts of law, following each case to its proper legal issue by the methods and rules of procedure in use by district attorneys. And each shall preserve a careful record of each case referred to him, and report the results to the State board of health.

The State board of health shall at its discretion provide office room, furniture, and attendants for its inspectors and law officers in their various localities.

Each member of the State board of health shall receive an annual salary of two thousand dollars, and the president of the board shall receive one thousand dollars additional annual salary: *Provided*, That any member who fails to attend any meeting of the board, or any part of any meeting, shall forfeit and lose one-twelfth part of the annual salary to which he may have been entitled for every such meeting or part of a meeting which he may have failed to attend.

The secretary of the State board of health shall receive an annual salary of three thousand dollars: *Provided*, That he gives his entire time and labor to the service of the board: *And provided*, That for any part of his time in which he does not do the duties of his office he shall not receive the pay.

Each member of the boards of inspectors, and of prosecution, shall receive an annual salary of four thousand dollars: *Provided*, That he shall be prohibited from entering into any other business or occupation than that of the State board of health: *And provided*, That he shall receive no perquisites nor fees, nor any other compensation of any kind whatever, but shall give his entire time and service to the State board of health for the annual sum of four thousand dollars: *And provided further*, That all time lost from any cause shall be deducted, *pro rata*, from his annual salary.

All authorized expenses and expenditures of the State board of health shall be audited and paid from the State treasury upon the vouchers of the president of the board, in the same manner and by the same rules as to the expenses of the State courts are paid.

All fines and receipts of money, from whatever sources collected or received under the provisions of this act, shall be paid into the State treasury semi-annually by the president of the State board of health.

On the 30th day of November of each year, the State board of health shall report its proceedings for the year to the governor of the State; said report to be transmitted by the governor to the next succeeding session of the legislature, with such comments or suggestions as the governor may see fit to make.

BROOKLYN, *January* 10, 1879.

DRAFT OF A PROPOSED LAW TO REGULATE THE PRACTICE OF PHARMACY AND THE SALE OF POISONS, AND TO PREVENT THE ADULTERATION OF DRUGS AND MEDICINES.

Whereas the safety and welfare of the public is endangered by the sale of poisons by unqualified or ignorant persons; and whereas in all civilized countries it is found necessary to restrict this species of traffic, and to provide by law for the regulation of the delicate and responsible business of compounding and dispensing the powerful agents used in medicine; and whereas the adulteration and sophistication of drugs and medicines is a species of fraud which should be prevented and suitably punished: Therefore, be it enacted, &c.

SECTION 1. From and after the —— day of ——— it shall be unlawful for any person to keep open shop for retailing, dispensing, or compounding medicines and poisons, unless such person shall be a *registered pharmacist* within the meaning of this act, and shall also conform to the regulations as to the keeping, dispensing, selling, and compounding poisons hereinafter provided; and every shop kept open for the retailing, dispensing, and compounding of medicines and poisons shall be under the direct personal care, oversight, and management of a registered pharmacist or registered assistant in pharmacy; and every registered pharmacist owning more than one such shop shall employ at every such shop, except the one he himself manages, a registered assistant in pharmacy to manage and supervise that particular shop only.

SEC. 2. No person shall be allowed to assume, use, or exhibit the title of *registered pharmacist or registered assistant in pharmacy* unless he shall have actually been registered as such in accordance with this act.

SEC. 3. No person shall be entitled to become a registered pharmacist unless he be either a graduate in pharmacy, a practicing pharmacist, or a practicing assistant in pharmacy.

SEC. 4. *Graduates in pharmacy* shall be understood to be such persons only as have obtained the diploma of a regular incorporated or chartered *college of pharmacy* within the United States, and also persons possessing a diploma or degree from some pharmaceutical institution situated in a foreign country, said diploma being acknowledged and indorsed by the pharmaceutical board of this State as sufficient to entitle such person to be considered a graduate in pharmacy.

Practicing pharmacists shall be understood to be such persons only as at or prior to the passage of this act have kept and continue to keep open shop within this State for dispensing and compounding the prescriptions of medical practitioners, and for the sale of drugs and medicines.

Practicing assistants in pharmacy shall be understood to be such persons only as shall have attained the age of twenty-one years, and who shall have served four years' apprenticeship in a shop where the prescriptions of medical practitioners were dispensed or compounded, and who shall have passed an examination by the pharmaceutical board of this State, as hereinafter provided.

SEC. 5. On or before the first day of June after the passage of this act, and every third year thereafter, on or before the same date, the incorporated colleges of pharmacy and pharmaceutical societies of this State shall submit to the governor the names of twenty pharmacists or professors in colleges of pharmacy, out of which number the governor shall appoint seven persons, who shall constitute the pharmaceutical board of the State of ———, who shall hold office for the term of three years, and until their successors shall have been appointed; and in case of removal from the State, resignation, or death of any member, the governor shall appoint in his place a registered pharmacist or a professor in a college of pharmacy to serve as a member of the board for the remainder of the term.

SEC. 6. The duties of the pharmaceutical board shall be to examine all candidates presenting themselves; to direct the registration by the registrar of pharmacists of all persons properly qualified or entitled under this act; to cause the prosecution of all persons violating its provisions; and to report annually to the governor on the condition of pharmacy in the State, and such suggestions as they may deem expedient.

Four members of the pharmaceutical board shall constitute a quorum; they shall organize by the election, for the entire term, of a president and a secretary, who shall sign all certificates and other official documents; they shall meet at least twice a year, and shall have power to make by-laws for the proper fulfillment of their duties under this act; they shall likewise have power to prepare a list of foreign pharmaceutical institutions or colleges, the diplomas of which will be recognized as equivalent to the diplomas of colleges of pharmacy in the United States, and to indorse their approval on any such diploma when presented to them. For said indorsement they shall be entitled to a fee of five dollars.

All persons applying for examination shall pay to the pharmaceutical board ten dollars; and if passing the examination, shall be furnished with a certificate in accordance with schedule E of this act, for which certificate no fee shall be exacted or paid.

SEC. 7. Immediately on the passage of this act the governor of the State shall appoint a *registrar of pharmacists*, who shall hold office for three years, at the end of which time a successor shall be appointed, or the same person reappointed; and in case of death, resignation, or removal of a registrar before the expiration of his term of office, the governor shall appoint some person to fill the office for the remainder of the term.

A registrar guilty of any misconduct or malfeasance in office shall, in addition to the penalties hereinafter provided, be removed from office and a successor appointed by the governor.

SEC. 8. The duties of the registrar shall be to keep a book in which shall be entered, under the supervision of the pharmaceutical board, and in the form set forth in schedule B to this act, the name and place of business of every person doing business in this State who shall apply to him in the form prescribed in schedule C to this act, producing proper evidence in accordance with sections three and four of this act that he is a *graduate in pharmacy* or a practicing pharmacist, or a duly qualified *practicing assistant in pharmacy*. It shall also be the duty of the registrar to erase from his register the name of any registered pharmacist who may have died or removed from the State, and to make all necessary alterations in the location of persons registered under this act. For the first registration as registered pharmacist, the registrar shall receive a fee of five dollars: *Provided*, That all persons in business at the time of the passage of this act shall be entitled to registration on paying one dollar.

And in order to enable the registrar to duly fulfill the duties hereby imposed upon him, it shall be the duty of every registered pharmacist, upon changing his place of business, to forthwith notify the registrar by letter of such change, and to inclose a fee of one dollar, upon receipt of which notification and fee the registrar shall make the necessary alterations in his register. And it shall be the duty of every registered pharmacist to communicate by letter to the registrar each year, on the first day of December, whether he still continues practicing pharmacy at his registered place of business, and to inclose a fee of one dollar for the insertion of his name and business address in the register for the ensuing year; and on or before the tenth day of January in each year, commencing with January, 18—, said registrar shall notify every registered pharmacist who shall not have written to him as aforesaid; and in case an answer, inclosing an additional fee of fifty cents, shall not be received by the registrar within fourteen days, such registered pharmacist shall be stricken from the register, and his name be at once reported by the registrar to the president of the pharmaceutical board: *Provided always*, That his name shall be restored to the register on payment to the registrar of a fee of five dollars, and in case more than one year has elapsed since the date of sending the aforesaid notification, he shall also produce proper evidence of being entitled to registration, in like manner as if his name had never been registered. All aforesaid notifications sent by said registrar shall have printed on the outside an inscription directing their return to the office of the registrar, in case the persons to whom they are addressed cannot be found.

Graduates and practicing assistants in pharmacy shall, upon application to the registrar in the form set forth in schedule D to this act, be entitled to be entered as registered assistants in pharmacy at an annual fee of twenty-five cents.

The registrar shall, on written demand of any registered pharmacist or registered assistant accompanied by a fee of twenty-five cents, give him a certificate under his own hand, setting forth in the manner presented in schedule H to this act that such person is so registered.

No name shall be entered on the register except of persons authorized by this act to be thus registered, nor unless the registrar be satisfied by proper evidence, in accordance with this act, that the applicant is entitled to be registered.

The registrar shall, in the month of March of each year, cause to be printed and published, as nearly as may be in the form of schedule B of this act, a correct list of the names of all registered pharmacists and registered assistants, arranged in the alphabetical order of their surnames, with their respective places of business, and the printed list shall be entitled the *Official Register of Pharmacists* within the State of ———, a copy of which, or a certificate under the hand of the registrar, shall be evidence in all the courts of this State that the persons therein specified are registered according to the provisions of this act, and the absence of the name of any person from such printed register shall be presumptive evidence that such person is not registered according to the provisions of this act; and each and every registered pharmacist within the State shall be supplied by the registrar with a copy of said official register of pharmacists, to be sent by mail free of charge, and the postage thereon prepaid.

SEC. 9. Any registrar who shall willfully make or cause to be made any falsification in any matter relating to the said official register of pharmacists, and any person who shall willfully procure or attempt to procure himself to be registered under this act, by making or producing, or causing to be made or produced, any false or fraudulent representation or declaration, either verbally or in writing, and any person aiding or assisting him therein, shall be deemed guilty of misdemeanor, and shall, on conviction thereof, be sentenced to be imprisoned for a term not exceeding twelve months, nor less than three months, and in addition thereto may be fined a sum not exceeding one thousand dollars, to be paid into the State treasury.

SEC. 10. *And be it further enacted*, That any person not a registered pharmacist, who shall, after the —— day of ———, 18—, keep open shop for retailing or dispensing of medicines or poisons, or who shall take, use, or exhibit the title of *Registered Pharmacist*, shall for every such offense be liable to a penalty of fifty dollars, to be paid to the pharmaceutical board to defray expenses, and such penalty shall be sued for and recovered in the same manner as is now provided by the revised statutes of this State for the recovery of penalties in other *qui tam* actions: *Provided, however*, That in rural districts, where there is no registered pharmacist within three miles, it shall be lawful for retail dealers annually to procure licenses from the registrar of pharmacists, at a fee of one dollar, as retailers of poisons, and all sales of poisons by persons so licensed shall be recorded in a book kept for that purpose only, in the same manner as provided in section 13 of this act.

SEC. 11. And any registered pharmacist or authorized retailer of poisons, who shall fail to comply with the regulations of this act in regard to retailing, dispensing, and compounding of poisons, shall be liable to a penalty of fifty dollars for the first offense, and one hundred dollars for the second and every subsequent offense, and such penalty shall be sued for, recovered, and paid to the pharmaceutical board of this State in the manner provided in section 10.

SEC. 12. *But be it provided*, That nothing hereinbefore contained shall apply to, or in any manner whatever interfere with, the business of any practitioner of medicine who does keep open shop for the retailing, dispensing, or compounding of medicines and poisons, nor prevent him from administering or supplying to his patients such articles as may seem to him fit and proper, nor with the making and dealing in proprietary remedies (popularly called patent medicines), unless such medicines should be wholly or partly composed of any of the articles enumerated in schedule A, nor with the business of wholesale dealers in supplying poisons according to the ordinary course of wholesale dealing to retailers and physicians, and for use in the arts.

And upon the decease of any registered pharmacist, actually in business at the time of his death, it shall be lawful for any executor, administrator, or trustee of the estate of such registered pharmacist, to continue such business, if and for so long only as such business shall actually be conducted by a registered pharmacist or registered assistant in pharmacy; but if such person be not registered, he must cause himself to be registered within twenty days of his commencing to conduct the business of said decedent, under the same penalties as are prescribed in the tenth section of this act, which penalties shall be collected from the estate of said decedent.

SEC. 13. *And be it further enacted*, That from and after the —— day of ———, it shall be unlawful for any person to sell, either by wholesale or retail, any poison without distinctly labeling the bottle, box, vessel, or paper, and wrapper or cover in which said poison is contained, with the name of the article, the word poison, and the name and place of business of the seller.

Nor shall it be lawful for any registered pharmacist, or authorized retailer of poisons, to sell or dispense a poison without being satisfied that it is for legitimate use, and, before delivery to the buyer, making, or causing to be made, an entry in a book kept for that purpose only, to be preserved for at least five years, and to be always open to the inspection of the pharmaceutical board, the registrar of pharmacists, the board of health, the coroner, and the officers of the different courts, stating in the form set forth in schedule F, annexed to this act, the date of the sale, the name and address of the purchaser, the name and quantity of the article sold, and the purpose for which it is stated by the purchaser to be required: *Provided*, That no article shall be considered a poison, within the meaning of this act, unless such article be enumerated in schedule A, annexed to this act, or shall hereafter be declared a poison by law.

SEC. 14. The provisions of section 13 shall not apply to articles to be exported, nor to any articles forming part of the ingredients of medicine compounded in accordance with the written prescription of a practitioner of medicine; but all prescriptions, whether or not composed in part of an ingredient or ingredients declared by this act to be poisonous, must be carefully kept by the pharmacist on a file or in a book kept for that purpose only, and numbered in the order in which they are received or dispensed; and every box, bottle, vial, vessel, or packet containing medicine so dispensed, must be labeled with the name and place of business of the pharmacist so dispensing them, and be numbered with a number corresponding to that on the original prescription retained by the pharmacist on his file or book, as aforesaid. Such prescription must be preserved at least five years, and shall be open to the inspection of the writers thereof, and a copy must be furnished by the pharmacist, if demanded by either the writer or purchaser, or both, for which copy or copies the pharmacist shall not exact any fee.

SEC. 15. From and after the passage of this act, it shall be unlawful for the proprietor of any pharmaceutical shop to allow any person not a graduate or a practicing assistant in pharmacy to compound or dispense the prescriptions of physicians containing poisons, except as an aid under the immediate supervision of said proprietor, or a graduate, or a practicing assistant in pharmacy.

SEC. 16. From and after the passage of this act, all persons who shall knowingly, intentionally, and fraudulently adulterate or cause to be mixed any foreign or inert substance with any drug or medical substance, or any compound medical preparation recognized by the pharmacopœia of the United States or of other countries as employed in medical practice, with the effect of weakening or destroying its medical power, or who shall sell the same otherwise than in the unbroken original package put up by the manufacturer and labeled with his name and address, or who shall sell such unbroken original package knowing the article contained therein to be thus adulterated, shall be guilty of a misdemeanor, and on conviction thereof before the criminal court shall forfeit all the articles so adulterated and shall pay a penalty not exceeding one thousand dollars, and in addition thereto may be sentenced to imprisonment not exceeding one year; said fine to be recovered and paid over to the court.

SEC. 17. It shall be the duty of the pharmaceutical board of this State to appoint for such counties where the necessity therefor is deemed to exist, and subject to the approval of the court of quarter sessions, one or more experts; and whenever a distinct charge or accusation is made, under oath or affirmation, before an alderman or justice of the peace, that there is reasonable ground for believing that any dealer or manipulator of drugs, wholesale or retail, is guilty of any of the charges specified in section 16 of this act, such accusation to be substantiated by an examination or analysis of the alleged adulterated drug or preparation by said expert, together with a sample or samples of the articles examined or analyzed, the said alderman or justice of the peace may issue authority to search for and arrest the sale of the adulterated articles until the case can be acted on by the grand jury, and, if a true bill be found, until the court decides by competent testimony for or against the defendant.

SEC. 18. All other acts and parts of acts inconsistent with this act are hereby repealed.

SEC. 19. This act shall be known as the pharmacy and poison act 18—, and may always be so cited, described, and spoken of.

SCHEDULE A.

Aconite and its preparations.
Arsenic and its preparations.
Belladonna and its preparations.
Cantharides and the tincture.
Chloroform.
Cotton root and its preparations.
Corrosive sublimate.
Croton oil.
Cyanide of potassium.
Digitalis and its preparations.
Ergot and its preparations.
Henbane and its preparations.
Hydrocyanic acid.
Nux vomica and its preparations.
Opium and its preparations, paregoric excepted.
Oxalic acid.
Poison hemlock or conium.
Savine.
Strychnia and all poisonous vegetable alkaloids and their salts.
Tartar emetic.
Volatile oil of bitter almonds, of pennyroyal, of savine, and of tansy.
Proprietary or secret medicines recommended, sold or advertised as emmenagogues and parturients.

SCHEDULE B.

Date.	Name.	Place of business.	Qualifications.	Remarks.
1870. Jan. 10	A. B.	329 Broadway, New York.	In business within this State prior to the passage of the pharmacy and poison act, 18 .	
Jan. 11	C. D.	Athens, Greene County, New York.	Graduate in pharmacy of Maryland College, of class of 1862-'63.	Died June 11, 1870.
Jan. 20	E. F.	290 Fulton st., Brooklyn, N. Y.	Practicing assistant in pharmacy, examined by pharmaceutical board of this State on day of , 1870.	July 8, 1870. Removed to and carries on business on his own account at 48 John st., Ithaca, N. Y.; has passed examination of College of Pharmacy of the city of New York, June, 1870.
Jan. 29	G. H.	Middletown, N. Y., with A. B., city of New York.	Registered assistant in pharmacy. Graduate of the Mass. College of Pharmacy, class of 1868-'69.	Sept. 1, 1870. Commenced business on his own account, at 136 Lake st., Buffalo, N. Y.

SCHEDULE C.

Declaration by a person applying to become registered pharmacist under the pharmacy and poison act, 18—.

To the Registrar of Pharmacists of the State of :

I, ——— ———, doing business (or about to commence business) at ———, in the county of ———, State of ———, hereby declare that I kept open shop for dispensing and compounding the prescriptions of medical practitioners at ———, in the county of ——— and State of ———, on or before the —— day of ——, 18—; or, am a graduate of the ——— College of Pharmacy, class 18— ; or, am a graduate of the [foreign institution], my diploma having been acknowledged and indorsed by the pharmaceutical board of the State of ——, on [date]; or, am a practicing assistant in pharmacy, holding a certificate of qualification by the pharmaceutical board of this State, dated (as the case may be).

(Signed) ——— ———.
Dated this —— day of ——, 186—.
(Affidavit.)

SCHEDULE D.

Declaration by a person applying to become registered assistant in pharmacy.

I, ——— ———, of ———, hereby declare that I am a graduate of the College of Pharmacy, class 18— ; or, am a graduate of the [foreign institution, date], my diploma having been acknowledged and indorsed by the pharmaceutical board of the State of ———, on the [date]; or, am a practicing assistant in pharmacy, holding a certificate of qualification by the pharmaceutical board of this State, dated ——— ———; and apply to be entered as registered assistant in pharmacy.

(Signed) ——— ———.
Dated this —— day of ——, 18—.
(Affidavit.)

SCHEDULE E.

Certificate of qualification to be issued by the pharmaceutical board to practicing assistants in pharmacy.

This certifies that ——— ———, of ———, county of ———, State of ———, has produced satisfactory evidence to the pharmaceutical board of the State of ——— of having served not less than four years as an apprentice in a shop, or shops, where the prescriptions of medical practitioners were dispensed; has been properly examined by this board (appointed by the governor in conformity with section 5 of the pharmacy and poison act, 18), and, on ballot after such examination, is declared, by a proper vote of this board, to be competent to dispense poisons and compound medicines, subject to all legal restrictions. In testimony whereof the officers of this board have hereunto signed their names this —— day of ——, 18—.

[SEAL.]

SCHEDULE F.

Form in which registered pharmacists and retail dealers in poisons shall keep their poison-book.

Date.	Name of purchaser.	Name and quantity of poison sold.	For what purpose said to be required.	Remarks.

SCHEDULE G.

Form of license to be issued to retailers of poisons in rural districts.

I, ——— ———, registrar of pharmacists, at the written request of ——— ———, of ———, county of ———, State of ———, and upon his written declaration that no registered pharmacist is situate within three miles of his place of business, have, in accordance with the provisions of section 8 of the pharmacy and poison act, 18—, and upon payment by him of one dollar, do hereby issue to him this license, authorizing him to retail poisons under the restrictions provided in said act.

[SEAL.] (Signed) ——— ———,
Registrar of Pharmacists of the State of ,
Office, No. *Street,*
———,
———.

Dated this — day of ——, 18—.

Schedule H.

Form of registrar's certificate to be given a registered pharmacist or registered practicing assistant in pharmacy.

This is to certify that —— of —— ——, county of ——, State of ——, was entered, on the [date], at the office of the undersigned as *registered pharmacist* (*registered assistant in pharmacy*), in conformity with the pharmacy and poison act of this State.

Given under my hand and seal [town], this — day of ——, 18—.

[SEAL.] (Signed) —— ——,

Registrar of Pharmacists.

Pro memoria.

1. In its present shape, the proposed law recognizes all persons actually in business on their own account at the passage of the act as entitled to be entered as registered pharmacists.

2. All persons not then in business on their own account will have to submit to an examination, or become graduates in pharmacy, before they can become registered pharmacists.

3. The title "registered pharmacist" is applied for convenience only to those actually engaged in business on their own account.

4. The title "registered assistant in pharmacy" may be obtained by all graduates in pharmacy and (examined) practicing assistants in pharmacy.

5. Anybody may become an apprentice in pharmacy, and practically all are regarded as such until they have graduated at a college of pharmacy or have passed an examination before the pharmaceutical board; such then become *practicing assistants.*

6. The titles "graduate" and "practicing assistant in pharmacy" confer a certain standing in law, and, in consequence, a certain responsibility. All who are neither graduates nor (examined) practicing assistants are, in the eye of the law, still apprentices.

7. After an apprentice becomes a graduate or (examined) practicing assistant, he may become a registered pharmacist by opening a store.

8. The advantage a graduate possesses over a practicing assistant lies in his being entitled to become a registered pharmacist in all or any of the States (which enact this bill) simply upon the exhibition of his diploma, while a practicing assistant in pharmacy may accept a situation in any State, but cannot *take charge* or become *proprietor* of a store without being examined again in the State to which he has removed.

9. Hence, it follows that while proprietors of stores are *compelled* to register annually, and for this reason ought to have a distinct title, qualified assistants, whether graduates or (examined) practicing assistants, enjoy by virtue of their diploma or certificate of qualification all the rights and privileges to which they aspire, and the public the proper security; these are therefore not compelled to register, though it will be their obvious interest to do so.

10. The pharmaceutical board provided for in this law is to be appointed by the governor, out of nominations made to him by the several pharmaceutical organizations, and the registration is to be under the direction of this board. It is also made one of its duties to prosecute all persons guilty of violating any of the provisions of this law.

11. The registrar is to be appointed by the governor. He is to publish annually an official register of pharmacists, which will be a valuable list, of those authorized by law to prosecute the responsible business of dispensing medicines and poisons.

12. Practicing physicians and wholesale druggists and country storekeepers located three miles from any registered pharmacist are excepted from the action of this law, but the latter class must be licensed as retailers of poisons.

13. The provisions regulating the sale of poisons correspond nearly with those of the existing laws of some of the States. That restricting the independent compounding of prescriptions to graduates and assistants should be carefully considered by the association before its adoption.

14. The provisions for the conviction and punishment of adulterators of drugs and medicines, and for the prevention of the sale of the same, are believed to be such as public sentiment demands; and, whether found efficient or not, may be well enacted into law as a terror to evil-doers.

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THE ADULTERATION AND DETERIORATION OF FOOD.

[By R. C. Kedzie, president of the State board of health of Michigan.]

THE ADULTERATION AND DETERIORATION OF FOOD.

While food is a prime condition of the existence of every form of animal life, wholesome food is a necessary condition for the higher types of human existence. The kind and quality of food has much to do directly with the physical development of a nation, and indirectly with its moral advancement. The imperious demands of the animal life where its wants are imperfectly met overshadow the promptings of the moral nature. A hungry man is, for the time, a savage; if the hunger is chronic the savagery becomes equally enduring. The persistent gnawing of an empty stomach will obliterate sentiment and drown conscience alike in the Ute and Celt, in Hindoo and Anglo-Saxon. Cobden says, "Without a full belly there is no religion and without a whole pair of breeches no morality."

Fortunately for our own people the question of food supply does not press upon us for solution. America is the land of overflowing abundance. While we have enough for daily feasting from New Year's bells to Christmas chimes, we are yet the almoner of Providence to the nations of Europe to preserve her teeming millions from suffering and want, if not from famine.

Yet, with our amazing abundance of materials for food, it is questionable whether we eat better food than the inhabitants of the Old World. It is obvious that the abundance in quantity and excellence in quality of our own provisions do not in themselves necessitate a corresponding excellence in our food. We may fall short of the best results in alimentation for three reasons: 1, bad cookery; 2, deterioration; 3, adulteration.

Good cookery is that which develops all the nutritive materials in provisions, and presents them in their most appetizing and digestible form; any other kind of cookery is bad cookery. Perhaps as much food is wasted by bad cookery as is consumed upon our tables; and of the food we eat, one-half the food value is destroyed by bad cookery. Some one has said: "Americans have the best provisions and the poorest food." A Frenchman poured out the bitterness of his soul in the exclamation, "What a peoples! Fifty religions and only one gravy"!

I do not propose at this time to discuss the subject of the preparation of food for the table, although it is a matter intimately connected with health. I confine my attention to the *deterioration* and *adulteration* of substances used for human food in the United States.

The cereals occupy the most prominent position among the food materials of our people, and wheat holds the first rank among the cereals. Wheat comes nearer a perfect food than any other vegetable production, because it contains an abundance of both the nitrogenous and carbonaceous elements of food, with an ample supply of the phosphates and other mineral substances required for animal nutrition. A chemical analysis of seventy-seven specimens of wheat and wheat flour made in this laboratory in 1877 discloses the fact that in only one instance was the quality of albuminoids in flour found to be less than 9 per cent., and in only five specimens was it found below 10 per cent. The quantity of albuminoids is ample for the sustenance of the human system and for securing the complete digestion of the carbonaceous constituents of the flour. The large amount of nitrogen and phosphorus in wheat make it pre-eminently the food of brain-workers; and one cause of the intellectual activity and energy of the people of the United States may be found in the large consumption of wheat bread.

DETERIORATION.

Wheat may deteriorate:

1. *By being cut at the wrong period of growth.* By allowing the grain to overripen or become "dead ripe," a portion of the digestible carbohydrate becomes converted into indigestible woody fibre, the product of flour is diminished, and its quality lowered. An elaborate investigation into the composition of the wheat berry at different stages of growth is now being carried forward at this laboratory; the analyses have not all been completed, but enough to show that there is a marked increase of cellulose in overripe wheat.

2. *By development of diastase by sprouting of the grain*, by which a part of the starch is converted into sugar in the process of bread-making, giving a brown, sodden, sweet, sticky mass instead of light and crisp bread. The period of wheat harvest in 1857 was so rainy in the Western States that the wheat sprouted before it was harvested, and flour of a very poor bread-making quality was the result. Some persons reasoned that the grain must have lost some material or principle by sprouting, and concluded this must be alcohol, the restoration of which to the flour would remove the difficulty in bread-making; but the incorporation of alcohol with the sponge or dough was found to have no influence in retarding the transformation of starch into glucose, and "the bread still fastened the jaws together just as in chewing wax."

They next tried to check the action of the diastase in the flour by using a solution of alum in making the bread. The appearance of the loaf was greatly improved, but the dietetic value of the bread was greatly diminished by the alum. Lime-water was found to be as efficient as alum in checking the sugar-forming tendency in this flour, with much less injury to the quality of the bread. A peculiar nitrogenous material called cerealin lies near the bran in the wheat kernel, which has a transforming influence on starch similar to that of diastase. When whole wheat flour ("Graham") is used in making bread the loaf is sweet, sticky, and brown in color, not alone from the color of the bran, but because the cerealin has transformed a part of the starch granules into dextrine or sugar, thus destroying in part the white color of the starch. A whiter and less sodden loaf can be made from this Graham flour by the use of lime-water, which is found to have a similar control over the transforming power of cerealin that it has over diastase; the small amount of lime used would not injure the bread, but would serve to correct any acidity produced in the panary fermentation.

3. *By heating, banking, or even molding*, when kept in large bulk, especially when not thoroughly dry. Wheat thoroughly air-dry may be kept indefinitely without loss of vitality or of food value; but when it is even moderately moist and is kept in large bulk it rapidly deteriorates. This change is mainly confined to the nitrogenous constituents of the grain; the gluten becomes weak and incapable of fine vesiculation, and such altered gluten often acts as a ferment, changing the carbohydrates into lactic and acetic acids. For these reasons the bread made from the flour of such wheat is liable to be heavy (unvesiculated) and sour.

WHEAT FLOUR.

Flour may be of inferior quality because of deterioration of wheat from causes already noticed, or it may be deteriorated from any of the following causes:

1. *Improper grinding and dressing.* In all ordinary processes of grinding the friction of the rapidly revolving millstones against the grain, or even of the stones against each other, develops a large amount of heat, so that the crushed wheat comes from the stones quite hot; the joint action of heat and mechanical pressure seems to liberate water from a quasi-chemical combination in the grain, so that wheat which is apparently dry in the hopper comes from the millstones steaming freely, so that the freshly ground wheat appears hot and damp. Heat alone will liberate water in stale bread in a similar manner; if a dry loaf be inclosed in a tight tin box and heated in a dry oven to 212°, the loaf becomes soft and moist like new bread. If the crushed wheat is aired and cooled, most of the water set free by grinding again enters into intimate combination, so that the flour appears dry although it

contains 10 to 12 per cent. of water, just as the loaf revived by heat soon becomes dry and crumbly. A part of the water, however, has permanently escaped, for the flour usually contains one-tenth less water than did the wheat from which it is ground.

But the changes effected in grinding are not confined to variations in the amount of water. Where the stones are set close to produce a large amount of flour and are driven at a high rate of speed to grind as large a quantity of grain as possible in a given time, and where the cooling of the heated mass is imperfectly done, serious changes are made in both the carbohydrates and the albuminoids of the grain. Mitscherlich has shown that wheat which contains no sugar may yield, after being ground, as much as 4 per cent. of sugar. This transformation of the starch into sugar could not be produced otherwise than through the internal action of the gluten aided by air and superabundant moisture. When once the action sets in it quickly passes through the whole heap if not speedily checked either by cooling or drying the flour. The decomposed starch or sugar, when the mass is left to cool gradually in large heaps, soon enters upon the alcoholic and sometimes even upon the acetous fermentation. This action always takes place in the middle of the heap first and proceeds toward the surface—the air enveloped in the flour and the heat produced by the transition of starch to sugar and alcohol successively favoring the change most in the center. The affected flour has a gritty feel, not unlike that of gypsum, and of course makes very unwholesome bread. (Muspratt's Chemistry, volume 1, page 366.)

The deterioration in the nitrogenous constituents of the flour is more marked and more injurious than any changes in the carbohydrates. Not only has the gluten acquired the properties of a ferment, but its vesiculating power is greatly impaired, so that heavy and sour bread is the usual product of such flour. Many years ago, when I was engaged in the practice of medicine in a very new and sparsely settled part of this State, I was accustomed to provide my yearly supply of flour by selecting very choice wheat and sending a load of twenty-five to thirty bushels to be ground at one time, because the grist-mills were fourteen miles away in three directions. A grist ground at one mill never yielded a light and sweet loaf of bread; it was a year of "unleaven bread." Another grist of similar quality of wheat made a quality of flour which never failed to make light and sweet bread. So difficult was it to secure good and prompt vesiculation with the former kind of flour that the wife very forcibly called it "dead." It was dead beyond resurrection, for it never rose again. Such overground and overheated flour is usually of a bluish-white color instead of a light golden tinge; it is non-coherent, and when it has been compressed in the hand it breaks down into a more or less powdery mass when the hand is opened, instead of retaining the form impressed upon it by the hand. Good "lively" flour will usually give a cast of even the fine lines and markings of the interior of the hand which has compressed it, while "dead" flour will fail to exhibit this in any marked degree. The feel of such flour is also harsh and gritty rather than soft and velvety.

I regard the excessive heating in grinding as the primary cause of this deterioration in flour; imperfect aëration and tardy cooling of the flour exaggerates the bad effects of improper grinding. Many persons claim that irregularity in the action of the motive power by which the revolutions of the millstones are secured causes a liability to this deterioration, because too rapid motion will injure enough of the flour to initiate the changes which may extend to the whole mass. For this reason they prefer mills where falling water is the motive power rather than steam. This objection to steam power can only be valid where the governor works imperfectly.

2. *Flour deteriorates by improper storing.* While wheat in good condition may be preserved unchanged for an indefinite period, flour is very liable to change. An obvious explanation of this fact comes from the great increase of surface in consequence of minute subdivision in grinding, causing a corresponding increase of exposure to atmospheric influences. The action of the air and moisture is therefore vastly greater on the finely divided flour than on the compact cutide-covered wheat. The very breaking up of the nitrogenous tissue of the wheat kernel in grinding seems to promote molecular changes in the flour, just as an egg will putrefy for being so violently shaken as to break up its internal structure. Viability of structure seems to be a conservation force. But all the natural safeguards which nature has thrown around the gluten of the wheat berry are broken down in flour; and this substance, so complex in chemical composition and so liable to change, is left exposed in an exaggerated degree to the action of the natural forces which produce decay.

Hydrated gluten is especially disposed to putrefactive decomposition. In flour the gluten is in the powdery form until it combines with a certain amount of water; but if it absorbs this quantity of water from the air or any other source, it will undergo molecular change—much more rapidly if the temperature is elevated. If, therefore, the flour is stored in a damp place, or kept at a temperature above 75° F., and especially if exposed to the joint action of these two conditions, it is very liable to serious impairment of dietetic value. This may be secured when the molecular changes stop far short of putrefactive decomposition. The office of the gluten in flour is both physiological and physical; for the first, it serves as a plastic material in the repair of tissue-waste; for the second, it secures that vesiculating quality in dough which renders light and digestible bread possible. Gluten performs the same office for bread that white of eggs does for sponge-cake. Every cook knows that white of eggs may lose its peculiar sticky and adhesive quality—the power of entangling and holding bubbles of air, by reason of which it may be beaten into a persistent foam—long before it has acquired the least odor or taste which would forbid its use as food. In a like manner the loss of the sticky property of the gluten may long ante-date its putrefactive decomposition. The loss of vesiculating power is the first downward step in the deterioration of flour.

It is surprising how rapidly such changes may take place in flour of good quality. In some experiments upon the vesiculating qualities of a larger number of specimens of flour, this deterioration was forcibly brought to my attention. A specimen of flour of Tuscan wheat was found to have gluten of high quality. I separated by washing the gluten from four ounces of the flour, and baked the pat of gluten in a "quick oven," when the gluten, distended by the steam generated by the heat, swelled up into a plump and evenly vesiculated ball, measuring 117 cubic centimeters. The flour, in a common paper sack, was set aside in a damp closet for two weeks, at which time I desired to obtain a gluten ball from one hundred grams instead of the four ounces. I separated the gluten from this quantity of flour and baked it as before; but, instead of the puffy ball, I only obtained a small gnarly lump, measuring 30 cubic centimeters instead of 117. I tried the experiment repeatedly, but with no better results. The gluten had lost almost entirely its vesiculating property. I tested the value of the gluten in other ways, but only to show the same fact. The gluten had not disappeared, but had "lost its grip."

Flour is often damaged by being kept where it will absorb bad odors. Perhaps no food-material, except milk and the products of the dairy, is more sensitive to bad odors than flour. It should never be stored in the same room with strong-smelling vegetables or fish, nor where the nameless odors of the kitchen may reach it. Anything that taints the air of the room will impart the same smell to the flour stored in such room. It should be kept in a dry, airy room, exposed neither to extreme cold nor to great heat.

The quality of their bread is so intimately associated with the health of a people that it becomes very important to have some cheap and easy method of testing the quality of any flour in respect to bread-making. An "organic combustion" will give the data for estimating the total albuminoids, but this can only be made by a chemist, and even this does not determine the vesiculating quality of the flour. In bread-making, the *quality* of the albuminoids is as important as the *quantity*. Flour that contains a moderate amount of *strong* gluten will make better bread than flour which contains more gluten which has become weak and incapable of persistent vesiculation. I offer the following

METHOD FOR TESTING THE QUALITY OF FLOUR.

Gluten is insoluble in water, but is soluble in a solution of caustic soda. A solution of monocarbonate of soda will partially dissolve the gluten, forming a glairy mass like white of eggs, but the bicarbonate of soda has only a feeble solvent action on gluten. If a solution of gluten is made with a dilute solution of carbonate of soda, and carbonic acid liberated by the action of an acid, the bubbles of gas will be retained by the gluten in proportion to its vesiculating quality; if the gluten is strong the vesicles will be fine and will not rapidly break with the escape of gas, causing subsidence of the foam, nor will they coalesce with each other with the formation of larger bubbles and ragged cavities. But if the gluten is of poor quality the vesiculation will soon break down in the manner indicated.

Test solutions. Dissolve 3½ ounces of crystals of carbonate of soda (sal soda) in 24 ounces of water; weigh out 60 grains of the flour to be tested; place this in a porcelain or glass mortar; add one-half fluid ounce of the alkaline solution; rub this up with the flour till every part of the flour has been acted upon by the alkaline carbonate; let the whole stand for an hour; then pour the mixture of flour and alkaline carbonate into a tall glass vessel (an "oil-sample" bottle or hydrometer jar will answer the purpose); wash out the mortar with two ounces of water and add this to the flour mixture; intimately mix the materials by inverting the bottle once or twice; then add one-half a fluid ounce of the acid solution made by dissolving two ounces of crystals of tartaric acid in 24 ounces of water; mix the whole carefully by inverting the bottle, and place it upright to observe the vesiculation. If the gluten is of good quality, the bubbles for the first five minutes will be almost invisible; they will coalesce very slowly, and in a quarter of an hour only a few large bubbles will be seen near the top of the foam; at the end of an hour the surface of the liquid will still be covered with froth. If the fine vesicles rapidly change, the foam falls in a short time, and the surface of the liquid is bare of foam in any part, the flour is poor and will not make evenly vesiculated bread when raised by the panary fermentation.

By treating a number of specimens of flour in the same way, in vessels of the same size and at the same temperature (60° F.), it is easy to compare their bread-making qualities. In making such comparison it is very important to have the conditions alike, especially the temperature.

ADULTERATION OF FLOUR.

European writers have much to say about the adulteration of flour, which seems to be a frequent practice in the Old World. I have examined a large number of specimens of flour in this State, but have never found an adulterated article. I think that adulteration of flour is not common in the United States. We "have bread enough and to spare," and the profits of such dishonesty would hardly pay for the trouble.

INDIAN CORN.

In many parts of our country corn in various forms is largely consumed as food. If more care were exercised in preparing it for the table, its use would be much extended and its digestibility increased, because its food value is generally underestimated. All persons recognize the delicious qualities of green corn, but the ripened grain affords a nutritious and sapid food. The analyses made in this laboratory last year of thirteen leading varieties of Indian corn (air dry) give an average of 11.09 per cent. of albuminoids, 4.93 per cent. of fat, and 6.23 per cent. of sugar and gum. The sum total of albuminoids is but little below that of wheat, but the want of gluten deprives meal of the vesiculating properties of flour. The meal contains more fat and soluble carbohydrates than flour, and consequently makes a more sapid food than flour. Some persons complain of a harsh and rough taste in the products of Indian meal, but this may be remedied by prolonged cooking. The presence of so large an amount of fat renders meal, especially if finely ground, peculiarly liable to become rancid and bitter, the difficulty constantly increasing with age, particularly when improperly stored. This deterioration may be prevented or avoided by coarse grinding, keeping in a cool place, and by not keeping for a long time in the form of meal. The whole grain may be kept for a long time in good condition, while the meal rapidly deteriorates. It is better to use the recently-ground meal. In hominy there is less tendency to change, because the grain is not comminuted as it is in meal, and much of the fat is removed by the alkaline solution used to remove the hull.

Adulteration.—Corn meal is too cheap an article to be adulterated, and I have never heard of adulteration of this material in this country. It is sometimes gritty from the presence of earthy matters by reason of careless handling.

OAT MEAL

is coming into more general use, especially as a side dish for the breakfast table. It contains a large amount of phosphates, and hence is well suited for food of adolescents. It is rich in fat and liable to deteriorate from the same causes and in the same way as Indian meal.

BUCKWHEAT

affords a highly-prized breakfast dish for the winter season. Buckwheat flour is very often adulterated with shorts, the similarity in the physical properties of the two substances rendering such adulteration easy to conceal. This adulteration is now carried to such an extent that the peculiar quality and taste of buckwheat almost wholly disappear from the old-time favorite pan-cake.

GARDEN VEGETABLES

form a considerable part of the daily food of our people, and their use should be increased rather than diminished. The deplorable consequences of their entire absence or too limited use are written in the history of the scurvy, once the scourge of the sea. They are a valuable addition to our food by affording agreeable variety and by diluting the two concentrated foods which form the basis of our living. Most of these vegetables are very succulent and readily undergo change, either by losing water, becoming wilted and insipid, or by incipient putrefactive decomposition, as is shown by mold and mustiness. We must be on constant guard against this tendency to deterioration, especially when the vegetables are not brought fresh from the garden. The whole subject of market vegetables as related to the public health has been so ably treated by Dr. S. C. Busey, in a paper read before the American Medical Association, that I need not repeat what he has so well said. The one safe rule in regard to all vegetables for human food is that they must be fresh, crisp, free from wilting and the least tendency to mold and mustiness. Better eat dry bread than re-enforce this with vegetables which have turned the corner towards putrefaction.

The value of roots and tubers depends much upon the kind of soil in which they have grown. Potatoes, turnips, beets, and celery are much better when grown in a soil containing much vegetable matter. This is especially seen in potatoes, which are best when grown upon virgin soil, next best when grown upon ploughed-up greensward, and poorest when grown upon stiff, undrained clay, dressed with unfermented manures. Those raised upon the first kind of soil will cook dry and mealy; those raised upon the last will be waxy and strong.

All these vegetables deteriorate by exposure to air and light. Their growth was subterranean, and their complete preservation from deteriorating demands a similar seclusion. Poisonous alkaloids develop in the potato and celery when exposed to light, and I strongly suspect the same tendency in the parsnip. A potato which has lain all winter in the soil in which it grew is found to have a very different quality from one which has been wintered in the cellar in the usual way. These vegetables can be preserved from serious deterioration by placing them in tight boxes or bins in the cellar, covering them from the light and air by a blanket till "the sweating period" has passed by, and then sifting over the surface a thin but continuous layer of soil rich in vegetable matter. This layer of soil should be renewed from time to time (if it has been disturbed by removing vegetables), so as to exclude light at all times, and prevent too free access of air. The lower the temperature, short of actual freezing, the better.

FRUIT.

The direct food-value of fruit is small, but its demulcent and refreshing quality gives it value, and the influence of the vegetable acids is important in maintaining good health. As a general rule, fruits are best when ripened on the parent stem, and they are in the best condition when first plucked.

There are some fruits which will ripen or color after removing from the parent stock, such as the tomato and orange, and in a less degree the peach and grape; but such color-ripening is a delusion as compared with the results which may be reached in nature's way. Such sham-ripened fruits should be rejected whenever better-ripened fruit can be obtained. A striking exception to this rule of excellence by ripening on the parent stem is found in the pear and apple. The final ripening of these fruits consists mainly in the transformation of the pectose, which causes the woody hardness of the full-grown but unripened fruit. The transformations of pectose into the gelatinous acids of this group are found to take place more certainly and uniformly when the temperature is uniform and with limited exposure to the air. If, therefore, the pear and apple are removed from the tree whenever the stem will freely part by lifting the fruit, and such fruit is placed in drawers or boxes protected from too free exposure to air and kept at nearly uniform temperature, the pear of woody hardness is ripened into a luscious lump of buttery softness that fairly melts in the mouth, while the amount of sugar and the aroma are increased also by this house-ripening. The same is true to a less extent of the apple. To secure the best dietetic effects these fruits should be always house-ripened. Perhaps the high esteem in which American apples are held in England and French pears in this country is an indirect result of the house-ripening resulting from long transportation.

The method of preserving fruits in the fresh state by canning has been carried to such perfection that little need to be said on this subject. Glass jars are now made of so good quality and so cheap that they ought to drive tinned vessels out of the trade in preserving acid fruits. When we consider that tin is becoming so frequently alloyed with lead, and that the tin salts themselves, which may be formed by fruit acids, are injurious to the health, this conviction becomes more fixed. The most promising way to make tin vessels safe for such purposes is to electroplate the inside of the can with silver, as is done by a canning house in Baltimore. The method of preserving bottled fruits by adding a solution of bisulphate of soda (Spear's preserving fluid) has gone into disuse. Another secret preparation is now taking its place, and is sold at a high price as a secret preserving material. On analysis, I find this to be crystallized boracic acid. Water containing 2½ per cent. of boracic acid preserves fresh fruit without change of form or color, and appears capable of doing so for an indefinite period.

This mode of preservation is admirable for exhibition of fresh fruit, since the most delicate colors are not changed by the solution. I have not made any experiments to test its influence on the taste or wholesomeness of fruits. "In Sweden boracic acid is extensively employed for the preservation of meat and milk; and while it forms a sufficient antiseptic, food prepared with it is said to be perfectly fit for use." (Encyclopedia Britannica.)

ANIMAL FOOD.

Meat is an important constituent in the diet of our people. Probably no other agricultural nation consumes so large a proportion of animal food. When we consider meat either with respect to its carbonaceous (fatty) or its nitrogenous (muscular) constituents, we find it the most condensed form of food. The preservation of such food material from loss or deterioration is a matter of great importance. The proper keeping of meat implies something more than saving it from putrefaction; it must be kept in such a way as not to lessen its digestibility or its appetizing quality. Both these qualities are found in their highest perfection a short time after the animal has been slaughtered, and while it is still in the condition of "fresh meat." All forms of preserved meat, whether kept by drying, smoking, or salting, bear a similar relation to fresh meat in human food that hay does to grass in animal fodder; the less change in either material from the original condition, consistent with preservation, the better for food purposes. One important condition in the keeping of meat is that the natural salts shall be extracted the least possible. The presence of such salts as the phosphate and chloride of potassium contribute to the digestibility of meats, and they are essential to their palatability. When meat has been entirely deprived of extractive salts by prolonged boiling, it has been found that it will not sustain animal life, and that dogs will starve though abundantly supplied with such meat.

New England farmers, who annually salt down beef for family use are accustomed to carefully preserve their beef brine from year to year, estimating it quite a misfortune to lose their brine; they scald their brine from time to time, to coagulate and remove the dissolved albumen; it is not, therefore, the dissolved animal matters in the brine which makes it valuable, nor is it chiefly valuable for the trifling cost of salt and sugar for the brine, but they have found by experience that old brine will keep beef sweeter and more palatable than will new brine. The reason is that the old brine has become thoroughly charged with the soluble salts of fresh beef, and will therefore extract less of these salts from fresh beef than will new brine, and the meat preserved in such old brine is kept more nearly in its original condition. If such is the fact, it would be a good plan to dissolve a quantity of the phosphate and chloride of potassium in new brine, and thus prevent the diffusion of these salts into the brine. The method of preserving lean meat by the exclusive use of common salt is objectionable, because so much is required for this purpose that the meat becomes hard, tough, and difficult of digestion, and almost inedible. The addition of nitrate of potash, which prevented the absorption of such a large quantity of common salt by the meat, and also in some degree limited the diffusion of the potash salts, was an improvement on the old salt-junk; the addition of cane-sugar to replace a quantity of the salt was a still greater improvement. In "sugar-curing hams" some parties have substituted glucose in the place of cane-sugar, with very unsatisfactory results. Hams cured with starch-sugar are more liable to mold; when the meat is boiled or fried, the glucose blackens by the heat and becomes so bitter that it is hardly fit to eat. The method of curing meat by external application of salt and other antiseptics is faulty, because a quantity in excess of what is required for the external portions must be used in order that the interior parts may receive an adequate supply through the excessively salted outside. If we could transfuse throughout the carcass the necessary salts by means of the blood-vessels, we might use what is needed and just the quantity required for curing the meat of any animal, thus avoiding all injurious excess.

According to the following extract from the New York Tribune, this has been successfully accomplished in Australia:

"The latest Australian device for preserving meat is the injection of weak brine into the blood-vessels (soon as the animal is laid bare) from an elevated tank, through a pipe inserted in the left ventricle, driving out the blood through the right ventricle, after which a stronger brine is forced in until all the veins are full. It is stated that the distribution of the salt is thorough and the carcass perfectly preserved." The Australian method might be improved by dissolving in the fluid for injection, in addition to common salt, sugar and nitrate of potash, or even creosote in small quantity if the smoky flavor is desired in dried meats. Meat injected with antiseptic solutions could be transported to Europe in the whole carcass without refrigeration, except in very warm weather; meat cured *from within* by this process is equally cured in all its parts, and the largest carcass can be as effectually cured as the smallest cuts. Meats cured in this way may be treated with only such quantity of antiseptics as is required to preserve them from decomposition, and to render them most acceptable to the palate. No loss of salts by diffusion into the brine is possible, as no brine is used.

In the curing of smoked meats, such as hams and bacon, the method of internal curing promises excellent results. In sugar-curing hams in the dry way, it is difficult to secure such penetration of the curing material as to preserve the deeper portions lying near the bone. Dealers usually explore this part of the ham by thrusting in some instrument; when this brings out no taint when withdrawn, the whole ham is pronounced sound. If a nozzle, conveying a solution of salt, sugar, creosote, &c., could be inserted into the femoral artery of a fresh ham, and by hydrostatic pressure this preservative liquid could be forced into every part of the ham, we could then feel assured that the ham was cured throughout without any loss of natural salts, and with the least possible deterioration of food value. Such hams could be dried to any desired extent and then brushed over with a solution of silicate of soda, which is an energetic antiferment, and which might replace the sacking and whitewash now used to keep hams from insects.

OTHER ANTISEPTICS.

Boracic acid.—I have already spoken of the use of boracic acid in Sweden for the preservation of meat.

Sulphurous acid.—For preserving cuts of fresh meat for a short time, fumigation with burning sulphur has been highly recommended. Cuts of fresh meat are freely suspended in a tight box, beneath which a quantity of sulphur is burned so that the fumes may come freely in contact with the entire surface of the meat, which is left suspended in the gas for an hour or two. The surface of the meat is blanched somewhat, but the meat will keep free from all taint for many days, even in the hottest weather. It is claimed that such meat is not injured in the least by the sulphurous acid, and that no person eating such meat when it has been cooked in the usual way can distinguish it from fresh meat.

PORK.

In preserving fat meats the packer usually relies almost wholly upon common salt. If this is a good quality of coarse-grained salt, so as to insure the absence of the salts of lime, the packer feels assured that he will have no trouble in securing his pork, but he looks with suspicion on salt containing any appreciable quantity of lime in any form.

The salts of magnesia seem to be much more objectionable than those of lime. In his chemical reagents the chemist finds that solutions of magnesian salts are more prone to develop low forms of life than solutions of lime salts; germ development seems to be promoted by magnesia more than lime, and putrefaction is the result of germ development.

When pork is poorly cured it acquires a peculiar kind of taint popularly called "rust"; the pork, though not putrid, is yet unfit for food, and no one will eat it except from necessity. But pork which is well kept is still widely different from fresh pork, however much salt may be added to the latter in cooking—having lost an indescribable and peculiar sweetness of taste. Pork which has been cured so as to preserve this sweetness of taste has greater dietetic value. I have found black pepper very effectual in preventing any undesirable change in pork, and I use it in the following way in packing pork: The bottom of the barrel is first covered with coarse salt in the usual way, upon which a layer of pork is tightly packed; upon this ground black pepper is dredged until the surface is well blackened; then a layer of salt, then pork peppered as before, and so on till the barrel is filled. In a few days brine is applied in the usual way. Such pork will remain sweet for a long time, and can hardly be distinguished from fresh pork when prepared for the table. The deterioration of pork by the growth of *trichina spiralis* has given pork-eaters a rude shock. The remedy for this trouble is simple—eat no pork in any form that has not been thoroughly cooked.

EGGS

Are of themselves very valuable as food, and they are highly prized by the cook for their fine vesiculating quality. But they are very liable to change, and unless very carefully preserved they soon "survive the period of their usefulness." They are fit for food only when their reputation is above suspicion. In the transportation of eggs it is nearly as important that their internal structure should remain unharmed as that their envelope should remain unbroken. An egg whose "cover has slipped off" is difficult to handle, but an egg whose interior integrity is destroyed, soon is not worth handling.

The method of keeping eggs in a weak brine is unsatisfactory on account of hardening the yolk and loss of vesiculating property in the albumen. I think better results can be obtained by making a pickle for the eggs with a weak solution of boracic acid, one-third of an ounce of acid to a pint of water. The silicate of soda might be used with good effect; the eggs might be varnished with a strong solution of the silicate, or a pickle made by dissolving one part of the dense solution of the silicate of soda in ten parts of water.

MILK comes nearer a perfect food than any other natural production. It is the universal food of the infant mammalians, and even adults use it largely for food. Many tribes distinguished for their physical endurance use milk as a leading article of diet. But, while good milk is a wholesome food, milk that has been carelessly handled and not protected from contamination has sometimes proved a vehicle for the dissemination of typhoid and scarlet fever. In most of these cases it has been supposed that the fever-poison found its way into the milk by contaminated water used in washing the milk pails, or in impure water used to adulterate the milk. But in a few well-authenticated cases it would seem that the milk of cows provided with impure drinking water may itself be a cause of typhoid fever in persons using such milk for food; and this when the cows did not appear to suffer in health from the use of such water. For a very striking illustration of this subject I refer the reader to the report of Dr. T. H. Everts in Transactions of American Medical Association for 1876, page 432. In order that cows may give wholesome milk they must have good food, pure water, and clean surroundings, and the last condition is not least in importance. Can a clean thing come out of an unclean?

Milk being a very complex organic substance, tends to rapid deterioration. Many methods have been proposed to keep milk from deteriorating, such as bottling the scalded milk, condensing it to small bulk and adding cane sugar; the addition of alkaline substances to neutralize the lactic acid as it is formed, thus preventing the separation of the casein; or the addition of a small amount of some antiseptic substance, such as boracic acid or silicate of soda, to prevent the transformation of sugar of milk into lactic acid. Many of these plans seem to be based upon the assumption that the coagulating of the milk is the single change to be prevented in order to preserve milk, and if it can be kept sweet for any length of time its food value will continue unimpaired. But the curdling of milk is only one of many undesirable changes to which milk is liable. Milk is valuable for food because there is such an intimate combination of fat and casein in new milk; by long standing the fat will almost wholly rise to the surface (more rapidly if the milk remains fluid), and a permanent separation takes place between the two classes of food. The longer milk is kept, even if no souring takes place, the poorer it is for food. Freshness in milk should be the thing sought, rather than the use of delusive antiseptics. Antiseptics in food are the by-paths to indigestion.

Adulteration.

The one adulteration to which milk is liable is water. In a few instances other substances have been found, such as sugar or glycerine and chalk, which have been used to bring up the specific gravity when water has been used, but all other adulterants are but a drop in the bucket in comparison with the lake of water which has been fraudulently poured into milk.

SACCHARINE FOOD.

I place sugars and the whole class of sweets in a section by themselves, not because they differ essentially from other carbo-hydrates in food-value, but because they are used principally for their sapid quality, rendering insipid food not only more palatable but more digestible in consequence of the augmented secretion of digestive fluids. The keen relish with which the young receive this class of food seems to indicate that it has some intimate relation to the rapid formation of new tissue. Nature throws out a broad hint on this subject in the large amount of sugar found in milk. One striking feature of American diet is the large consumption of sugar in our food.

Dr. Letheby estimates that Anglo-Saxons annually consume an average of 41.4 pounds of sugar for each person; the Latin race 12.34 pounds; the Teutonic 7.3 pounds; Russians and Turks only 3.3 pounds. The large consumption of sugar is a modern innovation; the use of sugar in food was unknown in ancient times, and the word sugar is not found in the Bible. Solomon somewhat dogmatically asserted that "there is nothing new under the sun," yet he would have opened his eyes wide in royal astonishment if a lump of loaf sugar had been placed in his hands and thence transferred to his mouth. The solitary food-sweet of Biblical times was "honey in the honey-comb." Sugar in small amount was known to some of the early nations, but it was used as a rare and powerful medicine.

In absolute food-value there is no very wide variation among the different sugars; the most marked difference in chemical composition is that one kind of sugar contains one molecule more of water, with a corresponding loss of potential force. A sensation has lately been produced by the statement that glucose or starch-sugar is unwholesome, because it is identical in composition with the sugar found in diabetic urine, and the inference has been drawn that glucose would produce *diabetes mellitus*. Starch itself, and cane sugar, are both changed into glucose in the process of digestion. If glucose were as efficient in causing renal disease as some suppose, the grape-eating races of men should long ago have been wiped out of existence by diabetes, for the sugar of grapes is glucose. Pure glucose is as wholesome as any kind of sugar. When I say that the absolute food value of glucose and of sucrose is very nearly the same, it does not follow that a person may not be defrauded by the substitution of glucose in the place of sucrose. Such person may have just ground for complaint, for the following reasons:

1. We use sugar almost entirely *for its sweetness*, and not mainly for its general food-value. Two pounds of sucrose will sweeten as much as five pounds of glucose; pound for pound, we only get two-fifths of our money's worth when using glucose in place of sucrose.

2. Glucose is much more prone to mold and decay than sucrose under the same conditions. I have a specimen of starch-sugar, made in one of the large factories out west. When first received, it was a white solid block rather beautiful to look at; the taste at first was sweet, but it left a rough and bitter taste in the mouth, on which account I called it apocaleptic sugar. (Rev. x, 10.) It was broken up and stored in a glass fruit-jar, where it became in a few months so covered with mold and so musty in smell that no one would eat it.

3. The artificial glucose or starch-sugar now manufactured in such quantities from Indian corn is liable to contain a considerable amount of foreign substances from the materials used in the process of manufacturing. These residuary materials are useless as food and sometimes cause sickness in persons eating the sugar or sirup. I have found sulphate of iron (copperas) and sulphate of lime (plaster) almost always present, and usually in considerable quantity; occasionally, but rarely, I have found free sulphuric acid. Two instances have come to my knowledge where a number of persons were made alarmingly sick by eating such sirup. In both cases the sirup was found to contain a considerable quantity of copperas.

ADULTERATION OF CANE SUGAR.

The large amount of starch-sugar which is now manufactured from Indian corn, and the enormous profits which would be secured by adulterating the costly cane-sugar by this cheap sugar have led many persons to suppose that all our sugars are now largely adulterated with starch-sugar. The suspicion is a natural one; and if the sophistication were easy to make and capable of complete concealment there is little doubt that it would be extensively practiced. But in the case of well-crystallized sugars it is difficult to practice such sophistication in such way as to avoid detection. Glucose obtained by evaporating its watery solution is not found in the form of crystals, but in white, opaque, granular, hemispherical, or cauliflower-shaped masses, which would at once distinguish it from the clearly-defined crystals of cane-sugar. Glucose can be obtained in the form of sharply-defined needle-shaped crystals from its solution in alcohol of 95 per cent., but "the game would not pay for the candle." The glucose could be dehydrated in a current of dry air at a temperature from 130° to 140° F., and then powdered and added to crystallized sugar, but it would then appear as floury dust in the sugar; the powdered glucose would be liable to absorb water from the air, forming a deliquescent mass, which would either make the sugar moist, or on again drying would agglutinate the sugar together in irregular lumps. The existence of clean, well defined, non-coherent crystals, free from floury dust, is good evidence of the absence of glucose from commercial sugars. I have analyzed a larger number of "granulated," "crushed," and "powdered" sugars without finding glucose in a single instance. Perhaps I have had a run of bad luck in looking for adulterations in this quarter, but I must confess to a complete failure in my hunt for glucose, tin-salts, lead-salts, terra alba, and all other adulterants in these sharply-crystallized sugars. Possibly my defeats have made me skeptical, but I am disposed to doubt the "common sophistication" of these sugars. Negative testimony can never become positive proof, and I would not be understood to say that such sophistication never takes place; I can only say I have never found them. In one instance I heard of a sugar in Lansing which I supposed to contain chloride of tin, from its turning from a white to a brown color (possibly from formation of "Maumene's caramelin"), but the sugar was returned to the wholesale dealer before I could obtain a specimen. In sugars not so distinctly crystalline, such as various grades of coffee-sugar, brown sugar, &c., adulteration by glucose is more feasible. In one specimen of "coffee C," I found 5.75 per cent. of glucose; in another 2 per cent.; in two others 1⅞ per cent.; in "extra C" 1⅞ per cent., and in "A" 1 per cent. This does not show very heavy adulteration. In the common candies where the crystalline form is purposely avoided as far as possible, glucose is often used in large quantities.

TABLE SIRUPS.

In table sirups of various names "sugar-house drips," "golden drips," "silver drips," "rock-candy drips," &c., the substitution of glucose in place of cane-sugar is very general. In 1874 I made a report to the State board of health of Michigan, "concerning impurities and adulterations in table sirups," in which I showed that 15 out of 17 specimens of table sirup which I found in the market consisted mostly of glucose. I have lately made analyses of twenty-one specimens of table sirups, and find the following results, which express the percentage of glucose found in the total of sugar present, one hundred indicating that glucose is the only sugar present.

Commercial names.	Percentage of glucose in total sugar present.
	80
"Crystal drips"	22
	72
	100
	81
	95
	54
	39
"Golden drips"	98
	75
"Honey drips"	100
"Honey drips"	100
"Rock-candy drips"	88
	90
	87
"Silver drips"	100
(Pure cane sugar!)	00
	75
	96
"White drips"	86
"Golden drips"	82

RELATIVE VALUE OF SIRUPS MADE FROM GLUCOSE AND CANE SUGAR

According to Storer's Dictionary of Solubilities, a saturated solution of glucose (at 15° C.) has a specific gravity of 1.206, and contains 44.96 per cent. of sugar, and 55.04 per cent. of water. A gallon of glucose sirup, therefore, would contain a trifle more than 4½ pounds of glucose.

A saturated solution of cane-sugar at the same temperature would have a specific gravity of 1.345, and would contain 66⅔ per cent. of sugar. A gallon of cane-sugar sirup would contain 7.17 pounds of sugar. If we adopt the estimate of Prout, that glucose has only two-fifths the sweetening property of sucrose, we come to the conclusion that one gallon of sirup made from cane-sugar has more sweetening power than four (4.17) gallons of glucose sirup. If sucrose sirup sells for 100 cents a gallon, glucose sirup should sell for 24 cents to represent the money cost by an equivalent value in sweetness. It may be objected that this is an unfair mode of estimating the relative value of these sirups because the glucose has a food-value aside from its sweetness. I answer that the glucose sirups, cheap as they are, are an expensive form in which to purchase the carbohydrates for their mere food-value, because the sugar and starch in a bushel of corn are equivalent to the carbohydrates in nine gallons of glucose sirup.

HONEY.

At first sight we would naturally suppose that honey, that extract of a thousand flowers, would be pure, and safe from adulteration. Men felt that they could trust the honesty of the honey-bee however much they might suspect that of her owner. But it is found that the bee is often made an instrument of unrighteousness. Not only is extracted honey largely adulterated with glucose sirup, but the honey in the comb frequently consists of little else than sirup of glucose. Enterprising parties at the East have been advertising a secret in honey making by which a person may make a profit of from 300 to 500 per cent. If a person sends $5 for this secret he finds it essentially consists in directions to feed glucose in some form to the bees, which will store it up in the comb in large quantities. A person disgusted with all kinds of "drips" and every form of starch-sugar thus turns to comb-honey for a pure sweet only to meet his old foe in new armor. Honey is the concentrated nectar of flowers; the bee *gathers* but does not *make* honey. Recent experiments at this college show that when bees are freely supplied with glucose or sucrose, and shut off from other sources of food the honey they store up in the comb consists essentially of the sugar they have imbibed; they cannot to any great extent change sugar into honey.

This substitution of starch-sugar in place of honey is a shameless fraud, and imperils an important industry—bee-farming. A very promising foreign demand for honey will soon stop unless this fraud is prevented. Congress ought to pass a law to protect the bee-keepers and the honey-eaters. It may not have power to prevent persons feeding glucose to their bees, but it can compel them to label their honey for just what it is, or send them to prison for obtaining money under false pretenses if they sell such stuff for honey.

BAKING POWDERS.

Baking powders have only an incidental connection with food, yet they are so frequently used in place of the panary fermentation to vesiculate various articles of food and have such a wide variation in quality, that I will briefly call attention to them. Most baking powders consist of cream tartar and bicarbonate of soda combined in equivalent proportions, with addition of a small amount of dehydrated starch to keep the materials sufficiently dry to prevent chemical action before they are used. The bicarbonate of soda as found in commerce is usually of good quality, but cream tartar varies greatly. One good property of cream tartar for such uses is that it dissolves somewhat slowly, and does not liberate the whole of the carbonic acid in one rush, leaving the dough to fall during the process of baking, but liberates the gas progressively, so as to leave a well-rounded loaf as the final result. If cream tartar and bicarbonate of soda could be obtained chemically pure, they should be combined in the proportions of 47 parts of cream tartar to 21 of bicarbonate of soda to form sodio-potassic tartrate, with liberation of carbonic acid; but as cream tartar usually contains at least 5 per cent. of neutral salts, good results may be obtained by combining 7 parts of best commercial cream tartar with 3 parts of bicarbonate of soda, and 1 part of starch dried at 230° F.

The value of commercial baking powders may be measured by the amount of gas which the same weight of powder will give off when placed in water. I have tested several kinds of baking powders which I have bought in the open market, by placing the same weight (10 gramms) in a flask with 250 cubic centimeters of water, and measuring the volume of gas given off in half an hour. The following table gives the commercial name of the baking powder and the number of cubic centimeters of gas given off:

1.	Price's Cream Baking Powder	380
2.	Royal Baking Powder	348
3.	Cook's Delight	335
4.	Condensed Baking Powder	320
5.	Horsford's	277
6.	Craig's	240
7.	Judd & Dewick's	220
8.	Dooley's	200
9.	Snow Flake	198
10.	Gillett's	196
11.	Baking powder (in bulk)	166
12.	Gates' No. 1	140
13.	Empress	104
14.	Peerless	90
15.	Cream tartar (7) bicarbonate of soda (3)	520

Cream tartar varies widely in quality and value, as is shown by the following results of analysis of representative specimens:

No. 1 contains 92 per cent. cream tartar.
No. 2 contains 88 per cent. cream tartar.
No. 3 contains 90½ per cent. cream tartar.
No. 4 contains 21 per cent. cream tartar and 79 per cent. of sulphate of lime.
No. 5 contains 14 per cent. cream tartar and 86 per cent. of sulphate of lime.

Cream tartar which contains from 79 to 86 per cent. of plaster is a poor article indeed, yet I obtained these specimens from first-class grocers, who boasted of the excellence of their cream tartar, and honestly supposed they were selling a good article.

STATE AGRICULTURAL COLLEGE,
Lansing, Mich., December, 1879.

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RESEARCH ON THE EFFECTS OF INOCULATING THE LOWER ANIMALS WITH DIPHTHERITIC EXUDATION.

[By Drs. H. C. Wood and Henry F. Formad.]

The object of the research which we have the honor to report to your board was to determine whether it is possible to produce diphtheria in the lower animals by the inoculation of the exudations from diseased human subjects. The experimental results and theories promulgated by Oertel, Trendelenburg, and others are so well known that we shall give no detailed references to them, but confine ourselves to our own experimental researches and the discussion of essential facts. There can be no doubt that animals not rarely die of pseudo-membranous affections offering symptoms similar to these of diphtheria in man. An epidemic of such disorder amongst rabbits will be spoken of later from our own experience. It is, however, by no means certain that these pseudo-membranous affections in the lower animals are the same as the human disorder. In attempting the systematic investigation of the subject our first series of experiments were made to determine the effects of inoculating animals with membrane taken from persons sick with diphtheria. The poison was put in little pockets made with a lancet under the skin, or inoculated by scarification in the mucous membrane of the mouth; in many instances both methods were simultaneously practiced; unless otherwise stated no antiseptics had been used on throat near the time of taking away the membrane.

First series of experiments.—Inoculation of diphtheritic matter subcutaneously and in the mucous membrane of mouth.

Number of experiment.	Date of inoculation.	Animal.	Inoculation.	Recovery or death.	Result of post mortem, and of microscopic examination.	Remarks chiefly upon source of matter employed.
1	Apr. 22	Small rabbit, No. 1.	Inoculated on tongue with fresh diphtheritic membrane.	Remained perfectly well to May 16, 24 days, when they were accidentally killed.	No signs of diphtheritic inflammation anywhere. The spleen, lymph, glands, liver, and lung showed some tubercle granulations. The rest of the organs normal. No bacteria in the organs.	Case I.—Material taken by Dr. Cardeza from child, 3 hours previously to inoculation. Child's throat had been touched with tincture of iron and glycerine previously.
2	Apr. 22	Small rabbit, No. 2	Same as last			
3	Apr. 24	Small rabbit, No. 3	Same as last	Remained well	....	Same case. The throat for 24 hours previous to the removal had not been touched by anything.
4	Apr. 24	Small rabbit, No. 4	Same as last	Died May 10th	No lesions except lymphatic glands swollen and tuberculous; also spleen. No bacteria in organs.	Same case, and exudation as last.
5	Apr. 24	Large gray rabbit, No. 5.	Inoculated in mouth; had also a piece of membrane put under the skin of the side.	May 4, was feverish for several days; a hard lump developed on the side at the seat of inoculation consisting of cheesy matter. June 6, animal well, cheesy lump smaller but persistent. Animal remained well.	Cheesy matter composed of pus, compound granule cells, debris, and numerous bacteria.	Same case. The child recovered from the acute attack, which was followed by paralysis, finally resulting in death,
6	Apr. 29	Small albino rabbit, No. 6.	Inoculated with fresh diphtheritic membrane in mouth, tongue, roof, and pharynx, and also subcutaneously on thigh.	Died May 2, 70 hours after inoculation, in convulsions, which commenced 6 hours previous to death.	Small cheesy lump at the seat of subcutaneous inoculation. Tongue ulcerated; no signs of diphtheritic inflammation anywhere; all organs hyperæmic, otherwise of normal appearance, but upon microscopic examination tubercular granulations well marked in lung, liver, spleen, and lymphatic glands. No bacteria in organs, except lungs, where are also hemorrhagic infarctions.	Case II.—Removed by Dr. Dunmire from the throat of child a few hours previously.
7	Apr. 29	Small albino rabbit, No. 7.	Same as last	Animal remained well.........	....	Same case.
8	Apr. 29	Small rabbit, No. 8	Same as last	Remained well to May 1st, when killed accidentally.	Post mortem revealed no lesions ..	Case III.—From Dr. Cardeza; inoculation made 15 minutes after removal of the membrane from the child's throat. This case was in same family as No. 1, and originally apparently contagious.
9	Apr. 29	Small rabbit, No. 9.	Same as last	Remained well to May 16, when accidentally killed.		
10	Apr. 29	Albino rabbit, middle sized, No. 10.	Same as last	Remained well.		
11	Apr. 30	Rabbit, No. 3	Reinoculated with diphtheritic matter in mouth and subcutaneously. May 7, inoculated third time.	Remained well up to May 13th; found dead May 14th.	Small cheesy lump on thigh at the place of inoculation. All organs tubercular, otherwise to the naked eye of normal appearance. No bacteria in organs.	Case IV.—From Dr. James Collins, twelfth day of disease. Matter semi-liquid, mixed with blood. The case afterward died.
12	Apr. 30	Dog, No. 1	Inoculated with diphtheritic membrane in mouth and thigh.	Remained well	....	Same case.
13	Apr. 30	Large cat, No. 1. ..	Inoculated with diphtheritic matter in mouth and subcutaneously on right thigh.	Remained well; a large lump developed in skin at seat of inoculation, which eventually disappeared. No micrococci in blood.	....	Case IV.—From Dr. Collins. Case recovered.
14	Apr. 30	Rabbit, No. 11, large albino.	Same as last.			
15	Apr. 30	Rabbit, No. 12, large old albino.	Same as last	Remained well.		
16	May 1	Small rabbit, No. 13.	Same as last	A small cheesy lump developed at seat of inoculation; died May 12.	Slight exudation on the mucous membrane of the larynx and trachea, of grayish color, and translucent. Trachea and lungs much congested. All organs tubercular; in the lungs are seen profuse hemorrhagic infarctions, and numerous bacteria. No bacteria in the organs.	Case V.—From Dr. W. S. Stewart. Membrane inoculated fresh on the day of removal.
17	May 1	Large cat, No. 2. ..	Same as former	Remained well; lump developed on side and disappeared within a week, healing perfectly. No micrococci in blood.	....	Same case.

First series of experiments.—Inoculation of diphtheritic matter subcutaneously and in the mucous membrane of the mouth—Continued.

Number of experiment.	Date of inoculation.	Animal.	Inoculation.	Recovery or death.	Result of autopsy and microscopic examination.	Remarks.
18	May 1	Small cat, No. 3	Inoculated in mouth	Remained well		Same case.
19	May 1	Dog, No. 2	Inoculated in mouth, pharynx, tonsils, tongue, and also subcutaneously on the side, with fresh diphtheritic matter. The latter also given to the animal mixed with food.	Remained well. Killed June 11	Cheesy lump which had existed for a long while on the side found to have been absorbed; in its place found a hard lump, probably of cicatricial tissue. No lesions perceptible. Blood examined during life did not show any bacteria.	
20	May 4	Small cat, No. 4	Inoculated with dried diphtheritic matter in mouth and subcutaneously.	Remained well. Killed June 12.	No lesions found; blood did not contain bacteria.	Case VI.—From Dr. Frank R. Brunner. Membrane removed several days ago from woman of 45 years; apparently much decomposed.
21	May 4	Large rabbit, No. 14.	Same as in last experiment	Remained well. Has large lump at place of skin inoculation.	No lesions except a large cheesy lump on side. No microscopic examination made.	
22	May 4	Cat, No. 5	Same as last	Remained well. Killed June 12.	Large cheesy lump at the place of subcutaneous inoculation; no signs of diphtheritic inflammation; lungs highly congested, the remaining organs all appearing normal to the naked eye; but microscopic examination showed tubercular granulations everywhere; hemorrhagic infarctions in lungs; no bacteria in organs except lungs.	Case VII.—From Dr. Collins.
23	May 7	Large rabbit, No. 15.	Same as last	Remained well up to May 19. Found dead May 20.		
24	May 7	Small rabbit, No. 9.	Reinoculated with fresh diphtheritic matter in mouth and subcutaneously.	Killed accidentally	Post-mortem revealed no lesion	See experiment 9.
25	May 7	Small rabbit, No. 3	Inoculated the third time as before with fresh matter.	Died May 9	A small cheesy lump on thigh at the place of inoculation; all organs tubercular, otherwise to the naked eye of normal appearance; no bacteria in organs.	
26	May 9	Dog, No. 3	Inoculated in mouth and skin with fresh membrane.	Remained well		Case VIII.—From Dr. James Collins.
27	May 9	Small cat, No. 6	Same as the last	Remained well. Killed June 12	All had cicatrizing lump at place of skin inoculation; no other lesions detected; no bacteria in blood.	From Dr. James Collins.
28	May 9	Small cat, No. 7.				
29	May 9	Small cat, No. 8.				
30	May 11	Goat, No. 1	Inoculated in mouth and subcutaneously with fresh membrane.	Remained well		Case IX.—From Dr. H. C. Wood. Taken from a case the second day of the disease, the attack having been derived by contagion from the cases of Dr. Cardeza.
31	May 11	Cat, No. 9	Similar inoculation	Remained well		
32	May 11	Cat, No. 10	Same as before	Found dead June 11	No microscopic examina'ion made; specimen preserved.	

There are recorded in the table just given thirty-two experiments, in only six of which the animals died, unless killed accidentally or otherwise. The time between the dates of death and of the last inoculation was, Experiment IV, six days; Experiment VI, seventy hours; Experiment XI, fifteen days; Experiment XVI, eleven days; Experiment XXIII, thirteen days; Experiment XXV, two days. The question naturally arises as to whether the few animals in which the inoculation was followed by death died of diphtheria or of some other disease. There is only one sign which can be considered pathognomonic of the diphtheritic process, namely, the formation of false membrane in various parts of the body; and it is to be noted that only in one case were there any exudations present in any organ which could give rise to the slightest suspicion that the animal died from diphtheria. In this case, Experiment XVI, there was only an indication of exudation upon the trachea, which, whilst it may have been due simply to a catarrhal inflammation, presents some of the characteristics of false membrane. A microscopic specimen of this Ex. A, page 6.

It has been asserted by Oertel that animals which have been inoculated with diphtheritic material die with their internal organs infested with micrococci, and that the presence of these is characteristic of diphtheria. We have carefully examined the internal organs of the rabbits which died, as well as the blood of those which survived, and found no micrococci. In this our results are in complete accord with the very careful labors of Curtis and Satterthwaite.

The utmost care is necessary to prevent the entrance into the blood of bacteria from without. Thus, we have cut the jugular vein of a rabbit and examining the blood at once found it entirely free from bacteria. When, however, after the lapse of a few minutes the post-mortem was concluded and the heart opened, the blood therein contained possessed an abundance of these low organisms.

It will hereafter be shown that micrococci indistinguishable from those of diphtheria are abundant in thefalse membrane produced traumatically in the trachea of rabbits, and we therefore conclude that these organisms are at least not characteristic of diphtheria. If they be so, however, we must conclude that none of the animals which we inoculated took the disease; since no bacteria or micrococci were present except in the lungs, upon whose surface they may often be met with in animals which certainly have not been infected with diphtheria.

If our animals did not die of diphtheria, of what did they die? A study of the post-mortem reports will show that in every case the internal organs were tubercular and in many cases intensely so; also, that tubercular disease was found in the organs of rabbits which were killed some days after inoculation. It is therefore a very natural belief that in those cases in which death was long delayed it was due to tuberculosis. It certainly is very possible that when death takes place soon after inoculation, it may be the result of a non-specific blood poisoning, and not of diphtheria. In the experiments of Curtis and Satterthwaite death not rarely occurred in a very brief time; with us it was almost always very long delayed. The difference may have been from our using smaller portions of the diphtheritic material and inoculating less deeply than did those gentlemen. It is, perhaps, proper to call attention to the fact that in no case did inoculation in the mouth produce either local or general symptoms.

In order to discover whether the diphtheritic exudation acted specifically in the production of tubercle, or whether it merely set up a local inflammation which formed a focus of infection, we experimented by putting under the skin of rabbits small masses of innocuous foreign matters.

Second series of experiments.—Inoculation of foreign bodies subcutaneously.

Number of experiment.	Date of inoculation.	Animal.	Inoculation.	Recovery or death.	Result of autopsy and microscopic examination.	Remarks.
33	Apr. 19	Small rabbit, No. 16.	A piece of wood, fragment of a match, put below the skin in the posterior part of the neck and the wound closed by a suture.	Wound healed rapidly, but subsequently a small lump of cheesy matter was formed. The animal was feverish for several days. In the lapse of two weeks the lump disappeared, and the animal remained well to date, June 8.	....	The foreign bodies used here have been before the experiments thoroughly washed and cleaned.
34	Apr. 22	Small albino rabbit, No. 17.	Treated similarly..........	Wound healed rapidly, but within a few days a large lump formed; ulceration set in, and cheesy matter protruded from wound; animal became emaciated, feverish. Died May 13.	All organs appeared hyperæmic; liver contains several small abscesses and numerous small nodules, the latter also seen in lung and spleen; lymphatic glands swollen; microscopic examination revealed large collections of tubercle granulations in all organs; the proportion of white blood corpuscle increased; no bacteria in blood.	
35	Apr. 22	Small rabbit, No. 18.	A piece of clean glass put below the skin in the right thigh; wound closed.	Result similar to last, only slower. Died May 20.	Lesions similar to the last, but slighter in degree; hemorrhagic infarctions in lungs very marked.	
36	Apr. 25	Large albino rabbit, No. 19.	A piece of glass put deep below the skin in the right thigh; wound closed.	Wound healed at first, then severe ulceration set in, cheesy matter protruding from wound; the latter increased to four times the original size. Died May 10.	No decided lesions to the naked eye; microscopic examination showed all organs to be profusely tubercular; hemorrhagic infarctions in the lungs; echinococci cysts in the liver; no bacteria in the organs.	
37	Apr. 25	Albino rabbit, No. 20.	Treated similarly..........	Wound healed after slight suppuration. Animals remain well.		
38	Apr. 25	Small rabbit, No. 21.	Treated similarly with a piece of cork.			
39	Apr. 25	Small rabbit, No. 22.	Treated similarly with a small bunch of clean hair.			
40	May 6	Small rabbit, No. 23.	A piece of wood, fragment of a match, put deep below the skin in the right thigh.	Cheesy lump formed rapidly and protruded from wound. Died May 19.	All organs showed masses of tubercle granulations; no other decided lesion; no bacteria in the organs.	
41	May 6	Small rabbit, No. 24.	A piece of wire put below skin in the left thigh.	Cheesy lump formed; the wire ulcerated away. Died May 15.	Hemorrhagic infarctions in lungs; tubercle granulations everywhere, although not very marked; no bacteria in the organs; none in the blood.	

It will be seen that in five out of nine of these experiments tubercle was found after death; this large proportion apparently demonstrates that a simple local inflammation may in the rabbit act as a source of tubercular infection. Now, in our experiments, as in those of Drs. Curtis and Satterthwaite, where diphtheritic matter was inoculated, inflammation was almost always induced at the seat of the lesion, with the formation of large lumps containing cheesy matter. These facts being so, it is a fair deduction that the tubercles were secondary to these inflammatory foci, and were therefore an indirect and not a direct result of the inoculation. We believe, therefore, that diphtheritic membrane placed under the skin or in the muscles of rabbits may cause death in a few hours by the production of a blood poisoning, which is not accompanied by any specific symptoms or lesions; or, after many days, by the development of a secondary tuberculosis.

The method by which Trendelenburg asserts that he succeeded in producing diphtheria in rabbits consists in placing the exudation matter in the trachea. As our experiments have led us to attach no importance to micrococci as a test of diphtheria, we naturally have suspected that the membrane when placed in the trachea produces simply a trachitis. This suspicion has been strengthened by the observation that acute pseudo membranous trachitis and angina seem to occur in rabbits. Such an epidemic destroyed during the last winter a number of rabbits kept by one of us in a perfectly clean place. The rabbits first showed sickness by refusing food; examination then detected swelling of the tonsils with exudation upon them. There was high fever with increase of the local symptoms until the animals became entirely unable to swallow. Death occurred in from three to seven days, preceded by great difficulty of breathing and profound exhaustion. False membrane was abundant in the mouth and trachea. It showed on examination all the characteristics of diphtheria exudation. If it meets the approbation of the National Board we would like during the coming winter to determine experimentally whether it is not possible to produce at will such diphtheria-like epidemics; and also how far contagion has to do with the spread of the disorder.

The next series of experiments were undertaken to determine the correctness of the assertion of Trendelenburg that the introduction of pseudo-membrane into the trachea produces diphtheria. Unfortunately, owing to the coming on of warm weather, we have been unable to obtain a sufficient supply of exudation to test the subject fully, but it will be seen that in one of the four experiments made with dried exudation pseudo-membranous trachitis was produced. So that Trendelenburg's assertions, which have also been confirmed by Oertel, seem to be correct. But we do not feel that our experiments have as yet been sufficient to enable us to speak positively from personal knowledge.

Third series of experiments.—Inoculation with diphtheritic matter in the trachea.

Number of experiment.	Date of inoculation.	Animal.	Inoculation.	Recovery or death.	Result of autopsy and microscopic examination.	Remarks.
42	May 31	Large albino rabbit, No. 27. Fresh rabbit.	Inoculated with dried diphtheritic matter, mixed with water, in the trachea, from without.	Still alive and well, June 20.....	....	Case X.—Of diphtheria, received through Dr. Jaggard, about 24 hours after removal. The membrane dry and hard; apparently in perfect condition.

Third series of experiments.—Inoculation with diphtheritic matter in the trachea—Continued.

Number of experiment.	Date.	Animal.	Inoculation.	Recovery or death.	Result of autopsy and microscopic examination.	Remarks.
43	June 1	Albino rabbit, No. 10. See experiment 10.	Same as last.	Died June 6, 5 days after inoculation, in convulsions.	External wound had healed perfectly; some ecchymosis noticeable, and the subcutaneous tissue infiltrated and congested. The wound in the trachea did not quite heal; larynx and trachea are congested and covered by a delicate true pseudo-membrane, which reaches, near the larynx, a thickness of 1 mm. Microscopically, it also appears fully identical with the natural and with the ammonia false membrane, containing micrococci in large number. No bacteria in blood, none in organs. The organs are tubercular, more especially the liver, where large nodules can be seen even by the naked eye. No hyperæmia of organs, as in the ammonia specimen.	Same case.
44	June 14	Young albino rabbit, No. 37.	Inoculated with dried diphtheritic matter, mixed with water, in the trachea.	June 18. Evening. Animals apparently well; take food, &c.; breathing not much interfered with. The same evening killed rabbit 37; No. 38 was found dead June 19.	No lesions; no bacteria in blood, which was very carefully examined.	Case II.—Diphtheritic matter taken by Dr. Richard A. Cleeman from throat of patient untouched; inoculation about 36 hours after membrane was taken; it was dried quickly and was in good condition.
45	June 14	Young albino rabbit, No. 38.	Same as last.		No lesion; blood not examined.	Same as last.

As stated by Prof. Oertel and other observers, the injection of certain corrosives will produce in the rabbit pseudo-membranous trachitis. Our next series of experiments were performed to determine whether such production is possible in other animals than the rabbit, and also whether the membrane thus obtained resembles that occurring spontaneously or produced by the introduction of diphtheritic matter into the trachea.

Fourth series of experiments.—Injection of ammonia into the trachea.

Number of experiment.	Date.	Animal.	Inoculation.	Recovery or death.	Result of autopsy and microscopic examination.	Remarks.
46	May 15, 4 p. m.	Large albino rabbit, No. 11.	Injected three or four drops of aqua ammonia into the trachea from without, the trachea being laid bare and a small opening cut into it.	Died May 18, 1 p. m., in convulsions, 69 hours after inoculation. During sickness breathing of the animal was extremely affected, very forced, deep, the rabbit opening the mouth widely at each straining effort, and raising the head; did not take food except the last twelve hours before death, when he seemed to feel easier.	Wound in skin and muscles covering the trachea was suppurating; tracheal wound had healed. All organs strongly hyperæmic, and tubercular nodules recognizable by naked eye. On opening the larynx and trachea, a well developed pseudo-membrane of 1 to 3 mm. in thickness was seen, which reached below the bifurcation and into the smaller bronchia. It resembles fully in color, consistency, and easiness of detachment, the natural croupous membrane, and is perfectly identical with the latter upon microscopic examination. Bacteria are abundant, both in spheres and disseminated; none in internal organs except the lungs. Tubercles most prominent in the lungs, spleen, and lymphatic glands. Hemorrhagic infarction in lungs.	
47	May 15, 4 p. m.	Large albino rabbit, No. 12, about 4 years old.	Treated with ammonia similarly to the foregoing.	Died May 18, 4 p. m., 73 hours after inoculation. Animal seemed not to suffer and took food well; death in convulsions, which lasted about 3 hours.	External wound as well as that of the trachea had perfectly healed. Lesions perfectly similar to those of foregoing rabbit only less intense in degree. Tubercles more scarce; lungs less hyperæmic and less infarcted. No micrococci in blood; pseudo-membrane fully developed and perfectly similar to foregoing. Bacteria and micrococci present in membrane and in lungs, but none in other organs.	
48	May 28, 12 o'ck.	Albino rabbit, No. 7.	Treated with ammonia like foregoing rabbits, experiments 46 and 47.	Died May 30, 11 a. m., 71 hours after operation.	Lesions fully identical with last rabbit, experiment 47.	
49	May 28, 12 o'ck.	Cat, No. 7.	Same as last experiments, 46, 47, and 48.	Died May 30, 2 p. m., 50 hours after operation.	Lesions and well developed false membrane similar to those in the last three rabbits, but here absence of tubercles. No micrococci in blood, and none in organs.	
50	May 28, 12 o'ck.	Dog, No. 3.	Same as last	Great difficulty of breathing and inability to swallow followed the operation, but animal was artificially fed with milk, &c.; 12 days after the operation seemed to be recovering; killed June 9th.	Body much emaciated; skin wound healed, while tracheal wound was open yet; slight congestion of tissues around trachea. In many places on the mucous membrane of trachea traces of disappearing false membrane seen; whole trachea covered by thick tenaceous mucus containing large quantity of leucocytes, some giant cells, and bacteria in moderate quantity. Spleen highly tubercular, tubercles in liver, lymphatic glands, and some in lungs. No bacteria in blood taken from jugular vein immediately after death.	

Fourth series of experiments.—Injection of ammonia into the trachea—Continued.

Number of experiment.	Date.	Animal.	Inoculation.	Recovery or death.	Result of autopsy and microscopic examination.	Remarks.
51	June 8, 4.30 p. m.	Fresh rabbit, No. 25, about three months old.	Treated with ammonia similarly to foregoing five experiments, 46, 47, 48, 49, 50.	Died June 9, 4 p. m.; no convulsions.	Autopsy made immediately after death. Wound in skin healed; tracheal wound open; the tissues around latter strongly hyperæmic; trachea nearly filled by false membrane. A tested preparation of membrane taken five minutes after death showed the usual elements of a natural diphtheritic membrane with great abundance of bacteria; the blood did not contain bacteria. Lungs much congested; its vesicles largely filled with the croupous exudation, blood corpuscles, and bacteria. All other organs normal and not containing bacteria.	
52	June 8, 4.30 p. m.	Rabbit, No. 23.	Same as last	Died from effect of operation, too much ammonia having been given.		

The experiments which are recorded in the last table show that ammonia is able to produce in the cat and dog, as well as in the rabbit, a pseudo-membranous trachitis. Prof. Oertel states that the membrane produced by cauterization of the trachea differs from diphtheritic membrane in containing no bacteria. What has led him to such an assertion, we cannot comprehend. When the death occurred very quickly bacteria and micrococci may have been less abundant in the traumatic membrane than in that taken from the throat of patients, but when the animal survived some days and the bacteria had sufficient time to develop themselves—when, in other words, they were afforded as good opportunity of growth as in the natural disease—they were immensely abundant, in some cases seeming to make up a large part of the bulk of the membrane.

If it be possible to produce a fatal pseudo-membranous trachitis by placing the diptheritic membrane in the trachea, and not possible to cause septicaemia by inoculating other portions of the body with the same material, it would appear as though diphtheria might be originally a local disease with a subsequent septic poisoning. The scope for investigation here opened is very great; on account of the lack of time, we have not attempted, at present, to answer fully the questions which arise; we have, however, performed a number of experiments to determine whether any products of disease other than diptheritic exudations are capable of causing pseudo-membranous trachitis.

Fifth series of experiments.—Inoculation with foreign bodies, pus, &c., in the trachea.

Number of experiment.	Date.	Animal.	Inoculation.	Recovery or death.	Result of autopsy and microscopic examination.	Remarks.
53	May 19	Large rabbit, No. 14. See experiment 21.	Inoculated in the trachea with slough from a bed sore.	Wound healed rapidly, the animal recovering completely.		
54	June 3	Small rabbit, No. 28. Fresh rabbit.	Inoculated in the trachea and in the thigh muscles with exudation from throat of a scarlet fever patient.	Died June 12	Large cheesy lump on thigh. Some congestion and translucent mucus around tracheal wound which had not healed; no false membrane. No lesions in the organs; not examined for bacteria.	Case X.—From Dr. Fulton, the matter being produce of ulceration of a scarletinal sore throat.
55	June 3	Small rabbit, No. 29.	Inoculated in the trachea only with the same matter as last.	Died June 10	Skin wound healed; upon dissection a cheesy abscess found below subcutaneous tissue, pressing upon the trachea, and probably having been the cause of death. No other lesions perceptible. No bacteria in blood. None in organs.	
56	June 8	Small rabbit, No. 30.	Inoculated in trachea with the pseudo membrane produced by ammonia in rabbit No. 25, experiment 49.	Animal well, June 18		
57	June 8	Small rabbit, No. 31.	Same as last	Killed June 16	No lesions except congestion of trachea and large cheesy lump between the trachea and skin.	
58	June 8	Small rabbit, No. 32.	Inoculated in trachea with purulent mucus taken from trachea of dog No. 3, experiment 48.	Died June 11	No lesions in any organ perceptible; tracheal wound not healed. No bacteria in blood.	
59	June 9	Large rabbit, No. 33.	Inoculated with ichorous pus in trachea.	Animal well		
60	June 10	Small rabbit, No. 34.	Inoculated with pus in trachea.	Found dead June 11	No lesions except congestion of trachea.	
61	June 10	Small rabbit, No. 35.	Same as last	Died June 18	Large cheesy lump between skin and trachea. Wound in trachea not healed; on opening the trachea a distinct pseudo-membrane of from 1 to 1½ millimeters in thickness was found, prominently seen only below the tracheal wound, *i. e.*, in the lower half of the trachea and the bifurcation. Microscopically, this membrane was identical with the natural diphtheritic membrane and with those produced by introduction of ammonia, and of diphtheritic matter in the trachea. Bacteria in large quantity all over. Cheesy abscess was found in the left lung; many air vesicles of both lungs filled with a croupous exudation containing multitudes of bacteria; prominent miliary tubercle in all organs. No bacteria in the kidneys; blood not examined.	

Fifth series of experiments.—Inoculation with foreign bodies, pus, &c., in the trachea—Continued.

No. of experiment.	Date.	Animal.	Inoculation.	Recovery or death.	Result of autopsy and microscopic examination.	Remarks.
62	June 10	Small rabbit, No. 36.	Inoculated with ichorous pus in trachea, and also deep in muscle.	Died June 17................	Large cheesy lump upon trachea, the latter much congested. Within the trachea a very distinct pseudo-membrane was developed in the lower half, like in last experiment and of the same macroscopic and microscopic character. Croupous inflammation of lungs. Other organs normal.	

In looking over the last table, it will be seen that in two of the ten experiments pseudo-membranous trachitis was caused by the introduction of organic matter into the trachea. In both of the cases in which false membrane was produced the injected material was pus; and it will be noticed that only four such experiments were made, so that the proportion of successful result is very large; much larger indeed than with true diphtheritic exudation in our experiments.

Trendelenburg found that not only ammonia, but also various other chemical irritants are capable of causing the formation of false membrane in the trachea; many years since it was proven that tincture of cantharides will do the same thing. It would seem, therefore, that in the trachea the formation of a pseudo-membrane is not the result of any peculiar or specific process, but simply of an intense inflammation, an inflammation which may be produced by any irritant of sufficient power. This fact, certainly, is very suggestive in regard to the pathology of diphtheria, and whilst we are not prepared to commit ourselves to any theory, it does seem proper to call attention to certain facts as indicating a very simple explanation of the peculiarities of the disease.

It is certain that as in the lower animals, so also in man, will chemical irritants produce a pseudo membranous trachitis; we are also well assured that there is no anatomical difference which can be detected with the microscope between the lesions of true croup and diphtheritic angina. A difference has been believed by some pathologists to exist between the two diseases, in that in croup the membrane separates easily; in diphtheria with great difficulty from mucous membrane. This seems to arise from a misunderstanding. The mucous membrane of the fauces and mouth has a squamous not easily detached epithelium, and consequently membrane connected with or springing from such surface is firmly adherent. The epithelium of the trachea is columnar, ciliated, and detacheswith the utmost facility even in normal condition of the organ: hence membrane attached to it separates readily. The membrane of diphtheritic trachitis is always readily detached in the line of the epithelium. Our preparations also show that the exudation of the croupous inflammation excited artificially in the trachea is not merely superficial, but also extends below the basement membrane. Some of the best clinical authorities of the day teach that there is no essential clinical difference between true croup and diphtheria, cases commencing apparently as local sthenic inflammation and ending as the typical adynamic systemic poisoning. Every practitioner must have seen cases of angina in which he was in doubt whether to call the affection diphtheria or not; the very frequent diagnosis of "diphtheritic sore throat" is a strong evidence of this. There have been cases in which diphtheritic matters absorbed by a wound have produced symptoms very closely resembling those of ordinary septic blood poisoning from post mortem wounds, &c.; there have been cases of the formation of false membrane about wounds, &c., without any known exposure to a specific diphtheritic poisoning, indicating that the systemic tendency to this peculiar form of exudation is capable of being engendered by other than the specific poison of diphtheria; finally, diphtheria seems sometimes to be produced by exposure to cold.

A general view of these facts seems to indicate that the contagious material of diphtheria is really of the nature of a septic poison which is also locally very irritant to the mucous membrane; so that when brought in contact with the mucous membrane of the mouth and nose it produces an intense inflammation without absorption by a local action. Whilst absorption is not necessary for the production of the angina, it is very possible that the poison may act locally after absorption by being carried in the blood to the mucous membrane. Further under this theory it is possible that the poison of diphtheria may cause an angina which shall remain a purely local disorder, no absorption occurring, or a simply local trachitis produced by exposure to cold or some other non-specific cause may produce the septic material when absorption shall cause blood-poisoning, the case ending as one of adynamic diphtheria.

Some such an explanation as those here offered seems to reconcile the antagonistic opinions concerning the value of local treatment in diphtheria; because it is plain that the value of such treatment must largely depend upon whether the angina has or has not been preceded by absorption.

There is one more important clinical feature of the disorder, which under other views of the disease seems inexplicable, but which with the present theory is easily explained. Diphtheria differs from the exanthemata by the fact that one attack in no way protects against a second. It will be seen that the theories here put forward remove the affection entirely from any relation with exanthemata; placing it rather with septic diseases, which, as is well known, may recur indefinitely.

We want, however, distinctly to state that we do not consider these ideas to be more than suggestions, and it is useless to speculate, except as a guide to further experimental research: it does seem to us that there are now two pathways clearly open which if carefully followed must lead to important positive or negative results. The first of these consists in the making of careful culture experiments to determine whether there is or is not any difference between the bacteria of ammonia and diphtheritic false membranes; the second, the study of the induction of epidemics of pseudo-membranous angina and trachitis in the lower animals and the relation to these of the rapid cases of death produced in the lower animals by diphtheritic inoculation.

There is still another somewhat different view which seems also not repugnant to the known facts of the case. There may be bacteria, which although they offer no points of difference detectable by our best microscopes, are really very diverse. Two spermatozoa or two ova in the higher animals may seem to be exactly alike and yet be potentially widely separated. Although therefore the bacteria of an ammonia false membrane seem identical with those of a diphtheritic false membrane, they are not of necessity really so. Careful studies of the blood of patients who die of diphtheria should be made, but at present it seems altogether improbable that bacteria have any direct function in diphtheria; *i. e.*, that they enter the system as bacteria and develop as such in the system and cause the symptoms. It is, however, possible that they may act upon the exudations of the trachea as the yeast plant acts upon sugar, and cause the production of a septic poison which differs from that of ordinary putrefaction, and bears such relations to the system as to, when absorbed, cause the systemic symptoms of diphtheria. Now, these bacteria may be always in the air, but not in sufficient quantities to cause trachitis, but enough when lodged in the membrane to set up the peculiar fermentation; whilst during an epidemic they may be sufficiently numerous to incite an inflammation in a previously healthy throat.

Transverse section of trachea with artificially-produced (by ammonia) pseudo-membrane. Rabbit No. 26. Experiment 52. Wood and Formad. Magnified 250.

a. Superficial pseudo-membrane. *b.* Croupous exudate below basement membrane. Between *a* and *b* are seen some remains of surface epithelium. *c. Ecchymosis in submucous tissue and infiltration of tracheal glands* with blood corpuscles. *d.* Cartilage, *e.* Outer connecting tissue and muscular investment.

University of Pennsylvania, July 1, 1880.

SUPPLEMENT No. 8,
National Board of Health Bulletin.

STATEMENT OF THE EXPENDITURES AND OPERATIONS OF THE NATIONAL BOARD OF HEALTH FOR THE QUARTER ENDING SEPTEMBER 30, 1880.

NATIONAL BOARD OF HEALTH,
Washington, D. C., October 18, 1880.

SIR: In accordance with section 8 of the act approved June 2, 1879, entitled "An act to prevent the introduction of contagious and infectious diseases into the United States," the following statement of the operations and expenditures of the National Board of Health for the quarter ending September 30 is respectfully submitted for transmission to Congress. The preparation of this statement has been postponed for a few days beyond the usual period, in order to include the latest intelligence respecting an outbreak of a suspicious disease in the vicinity of the Mississippi quarantine below New Orleans, in regard to the nature of which there was much difference of opinion, but which there is now every reason to believe was a mild epidemic of yellow fever, as will be more particularly stated in another part of this report.

SPECIAL INVESTIGATIONS AND SANITARY SURVEYS.

1. Since the date of the last quarterly report of this board the sanitary survey of selected portions of Baltimore City, which had been undertaken in compliance with the request of the city council, as set forth in a correspondence between the mayor and the president of this board, a copy of which accompanied the quarterly report for this quarter ending March 31, has been completed, and the report of Dr. C. W. Chancellor, who had been appointed to conduct the work, has been forwarded to the mayor for transmission to the council. By reference to that correspondence, it will be seen that in consenting to institute this survey the board expressly disclaimed authority to apply the funds at its disposal to purposes of local sanitation. Accordingly the survey was ordered "not with the view of relieving that municipality of any part of the expense of needful sanitation, but in order to demonstrate to its authorities, by means of the results of such a partial survey, the urgent necessity for prompt action on the part of the council looking to the completion of a similar survey for the entire city, and to enforce the recommendation heretofore made by this board for a complete system of sewerage" on some uniform plan to be selected after a topographical survey of the city shall have been made by competent engineers. It is the opinion of this board that the method at present in use for the disposal of the excremental filth in that city is fraught with great danger to the future health of the community, and, in the event of the introduction of infectious disease, may imperil all the surrounding country.

2. The investigation by Prof. Raphael Pumpelly, of the United States Geological Survey, on the influence of various soils upon sanitation, especially with regard to drainage and the methods of disposal of excreta, promises to yield results of much scientific interest and great practical value. At the request of Professor Pumpelly, Prof. George A. Smyth has been associated with him in conducting this investigation, which involves a continuous series of very elaborate and difficult experiments.

3. The final report by Col. G. E. Waring of his investigation of the flow of sewers in relation to their sizes and gradients, has been received and has been published in the Bulletin of the National Board of Health, vol. 2, No. 6, a copy of which, marked A, is hereto annexed.

4. The final report of Dr. S. E. Chaillé of his work in connection with the Havana Yellow Fever Commission, an outline of which was given in his preliminary report heretofore transmitted to Congress, has now been received. It covers 500 pages of foolscap, and will occupy from 350 to 400 printed octavo pages. Three valuable maps accompany the report, viz: A, map of the so-called "yellow fever zone"; B, map of Cuba; C, map of "Havana and its harbor," and therewith of "Havana, its harbor, and suburbs."

It is believed that the publication of this report will prove one of the most valuable contributions ever made on yellow fever, and will undoubtedly be exceedingly useful as a book of reference on the subject of that disease as it exists in Cuba. It is therefore hoped that Congress will, at the approaching session, promptly provide for its publication.

5. Dr. G. M. Sternberg, of the United States Army, who was associated with Dr. Chaillé and others on the Havana Yellow Fever Commission, and who some time after the return of the commission from Havana was directed to continue his researches upon suspended particles in the air of places liable to infection, has recently been engaged in that work in the city of New Orleans, and in the somewhat kindred work of investigating organized particles from the swamps and well-known malarial regions in the vicintity of that city, with the view of verifying or else of disproving the observations which have been made by Klebs and Tomassi on the existence of spores in such localities, supposed to have a causal relation to malarial fevers. He is at the present time performing physiological experiments on living animals, with reference to the determination of this question.

6. The investigation by Dr. Charles Smart, U. S. A., into the adulterations of food has been so far advanced as to furnish satisfactory proof that such adulterations are sometimes practiced, and to make it important to extend inquiries in this direction. The investigation will accordingly be carried on during the remainder of the year at least.

NOMENCLATURE OF DISEASES.

At the conference held in Washington on the 6th and 7th of May, in accordance with a request of the National Board of Health as explained in the last quarterly report, the following resolutions offered by a member of this board were unanimously adopted:

"*Resolved*, That the nomenclature published by the Royal College of Physicians of London be provisionally adopted.

"*Resolved*, That a committee of five be appointed by the chair, whose duty it shall be to indicate the most urgently needed additions to said nomenclature at the present time, and that this committee shall be instructed to confer with the committee of the Royal College of Physicians in charge of the revision of said nomenclature with reference to obtaining a uniform system both for Great Britain and her colonies and for this country."

Recognizing the great importance of this subject in connection with its bearing on the means of securing an exact registration of the causes of death, this board has appropriated the sum of $500, or so much thereof as may be necessary, to defray the expenses of a selected member of the committee appointed under the above-cited resolutions, who shall be required to proceed to London and confer with the committee of the Royal College of Physicians engaged in the revision of the standard nomenclature of diseases.

The report of the committee on the best methods of tabulating mortality statistics is now ready and will be promptly published in the Bulletin of the National Board. There is good reason to believe that the tables prepared and recommended by the committee will be promptly adopted by most if not all of the registrars of vital statistics in the United States.

QUARANTINE.

The act approved June 2, 1879, the scope of which is foreshadowed by its title, "To prevent the introduction of contagious and infectious diseases into the United States," and the various requirements of which are in precise conformity with the import of that title, having imposed upon the National Board of Health certain obligations looking to the protection of the public health in that direction, it became a matter of anxious inquiry with the board how it could best and most efficiently perform the duties prescribed in the law. The decision of this question with reference to a general plan of operations for future seasons was, however, of necessity left in abeyance for a time, by reason of the fact that almost immediately after the promulgation of the law the board found itself confronted by an alarming outbreak of yellow fever in Memphis and by the occurrence of a few threatening cases in New Orleans. Subsequently the disease appeared in various other localities, as detailed in the first annual report of this board, which, with its appended documents, has heretofore been transmitted to Congress. The infection having been already introduced, to assist the authorities of the stricken communities in their efforts to stamp out the disease, as a necessary means of preventing its spread to other States, was recognized by the very highest legal authorities of the general government to be the obvious duty of the board under the provisions of the law which defined its powers. Owing, it is confidently believed, to measures recommended by this board and to the pecuniary aid extended to the authorities of the endangered communities to enable them to carry these recommendations into effect, the spread of the disease was actually restrained within very narrow limits.

This very desirable result having been accomplished, and the period of danger of further developments of infection being past by reason of the occurrence of early frosts, the inquiry again pressed itself upon

the attention of the board as to its duties with reference to the future prevention of the introduction of contagious and infectious diseases into the United States from foreign countries and from one State into another. In this connection the board did not overlook the great importance of maintaining, in the localities most exposed to the danger of the importation of infectious diseases, such an habitual condition of local sanitation as would be likely to render the poison when introduced *ab extra*, if not wholly inoperative yet much less potent for evil. To this end an elaborate sanitary survey of the city of Memphis was made by order of this board, and certain measures, especially with reference to sewerage and repaving of the streets, were recommended. These measures were promptly carried into effect by the authorities of that city, and we may well congratulate the citizens of that stricken and impoverished community upon the results of their manful determination to bear the expenses incident to the execution of the improvements recommended. Notwithstanding the unexampled mildness of the past winter, which excited the fears of many persons lest some of the germs of the disease which prevailed until late in the fall might retain their activity through the winter and cause a new outbreak this year, there has not been a shadow of suspicion of the occurrence of a single case of yellow fever during the year, and the general health of the city has been unusually good.

With a similar end in view the board sent two of its sanitary inspectors over to the Têche country in Louisiana, which had suffered more or less seriously from the invasion of yellow fever during the previous season, in order to ascertain its actual sanitary condition and what had been done by the local authorities in the way of local sanitation as a measure of prevention against the recurrence of an outbreak. It is not unreasonable to ascribe the immunity which that country has enjoyed the past summer from serious invasions of disease, in part at least, to greater care in regard to sanitary improvements consequent upon the action of the board.

But, whatever care be taken in regard to municipal cleanliness, it is beyond all reasonable question that infected vessels and their cargoes and infected articles transported by railroads may plant the germs of disease in even the most cleanly cities. Accordingly, the municipalities which resolutely determined to exclude the infection at whatever cost and inconvenience to their own citizens and to those who desired to hold commercial intercourse with them, are accustomed in times of great danger to maintain the policy of absolute non-intercourse, enforcing this policy when necessary by means of the so-called "shot-gun quarantine," the barbarous cruelty of which has been made familiar to the public by numerous well-authenticated incidents of the epidemic of 1878. The efficiency of this policy was, however, abundantly established by the immunity enjoyed by numerous towns in the Valley of the Mississippi which adopted it, while the infection prevailed everywhere around them. To remove all occasion for the use of such a measure, by securing an adequate protection of the public health with the least obstruction to trade and travel, was doubtless the motive which led to the passage of the act of June 2, which had for its end the prevention of the introduction of contagious and infectious diseases into the United States from foreign countries or from one State into another, and which accordingly made it the duty of the National Board of Health to co-operate with and assist State and municipal boards of health in their efforts to secure these ends by means of quarantine regulations. With reference to

MARITIME QUARANTINE

as a means of preventing the introduction of disease into the United States from foreign countries or from an infected port of one State into those of another State by sea, there were two conceivable ways in which this board might attempt to render aid to the local authorities. One was to make a *pro-rata* distribution of the funds at its disposal and available for this purpose to all the ports of entry which might seem to need such aid. This was at once rejected for the reason that, in addition to other more or less potential considerations, such, for example, as its opposition to the general tenor and spirit of the law and to the rulings of the Treasury Department, the distributive share of each beneficiary would have been so small as to render the act practically nugatory, inasmuch as a complete quarantine establishment is somewhat expensive with the original construction and as respects the annual cost of maintenance, including as it does a hospital for the sick, a lazaretto for persons not sick to be kept under observation until their freedom from infection is clearly established, a warehouse for the temporary storage of the cargoes of infected vessels, wharves to facilitate landing, lighters for conveying disinfected cargoes to the wharves of the port of destination, the seagoing vessels being sent to sea and thus returned to the uses of commerce in the shortest practicable time, and, finally, accommodations for the quarantine officer. To have given aid to this extent to all the exposed ports which needed it on the South Atlantic and Gulf coasts would have required more than ten times the amount of funds under the control of the Board. The only alternative seemed to be to select a few points so located as that a completely equipped quarantine station at each of them might avail for the protection of the intermediate ports, if their respective authorities would require all infected vessels bound for such ports to proceed first to these fully-equipped stations in order to undergo appropriate treatment. In such a case the ports themselves would need only the services of an inspecting officer to board vessels and to remand to the nearest national quarantine station such as had improperly attempted to enter the port against the published directions distributed by pilots.

As the stations thus proposed to be established were for the benefit not of a single State but of several, it was considered to be necessary and every way desirable to work them through the agency of employés directly responsible to the Board. The authority to do this was believed to be conferred by the law of June 2, 1879, inasmuch as it would be in aid of State and municipal boards of health, and this aid was to be extended at their request and with their active co-operation. The Board did not, however, take a step in this direction until it was fortified by the opinions of the legal advisers, namely, Solicitor-General Phillips, representing on this Board the law department of the Government; Judge Porter, First Comptroller of the Treasury, who, under the law, had to pass upon all its accounts; and of Senator Harris, chairman of the Committee on Epidemic Diseases, which had framed the act in question. In the opinion of the latter eminent jurist the Board would have been derelict of its duty if it had failed to inaugurate some such measure for the protection of the country from the introduction of infectious diseases from abroad.

In undertaking this work the Board had the advantage of the remarkably successful experience of the quarantine authorities of the State of New York in protecting not only the ports of that State but all those of New Jersey and Connecticut which are reached through the harbor of New York. In the earlier operations of that quarantine only the vessels bound for the city of New York were subjected to its regulations, and though they proved effectual to exclude the *direct* importation of infectious diseases, it was soon found that such diseases, having been carried up the Sound, gained admission into the city by land from ports and places in Connecticut. This led eventually to the subjecting to the regulations of the New York quarantine all vessels entering the harbor, whatever might be their ultimate destination. This, it is believed, has been done without special legislation, but with the ready and cheerful acquiescence of the authorities of New Jersey and Connecticut. In like manner the quarantine station in Boston Harbor may avail, and to some extent it is believed has availed, for the benefit of other ports on the New England coast. On the South Atlantic and Gulf coasts, where, owing to climatic peculiarities and proximity to the permanently infected ports of Cuba, quarantine treatment of vessels is specially necessary for the public safety, there are no wealthy municipalities able to protect themselves and their neighbors. Periodically they are inflicted with diastrous epidemics which entail commercial losses and untold misery not only on the population of the ports first infected from abroad, but over a wide extent of the surrounding country. In the opinion of this Board this gigantic evil may be averted to a very large extent by the establishment, at a comparatively moderate expense, of a few completely-equipped quarantine stations, which may give to the ports of the South Atlantic and Gulf coasts the same protection which the New York quarantine has secured for that State and for the ports of Connecticut and New Jersey. This Board ventures, at the hazard of incurring the charge of tedious repetition, to bring this subject again to the attention of the honorable Secretary of the Treasury for transmission to Congress, in view of the fact that the Committee on Appropriations, to whom it was presented during the last hours of the recent session of that body, were not fully informed of the force of the considerations which actuated this Board in taking measures for the establishment and maintenance of the quarantine stations in question.

In the quarterly report of this Board for the quarter ending June 30, after adverting to the importance of the establishment and maintenance of quarantine stations under the auspices and control of the Board at Hampton Roads, Sapelo Sound, and Ship Island, it was stated to be "a subject of regret that owing to recent legislation by Congress it has not been possible to carry out these views except in a very partial manner.

"The funds at the disposal of the Board have necessitated, in the case of Hampton Roads, a temporary abandonment of a national quarantine, substituting therefor aid to the local authorities by the loan of a barge, purchased and equipped as a floating hospital, at a cost not to exceed $6,000. This was found to be less expensive, and in all other respects much better than to repair and fit the hulk of the Savannah, lying at the navy-yard at Portsmouth, Va., which had been courteously granted for the use of the Board by the Secretary of the Navy. For a like reason a temporary arrangement has been made at the Sapelo Sound Station by the use of hospital tents on the southern end of Blackbeard Island, and by the purchase of a steam launch for boarding vessels. The erection of a hospital, lazaretto, warehouse, and wharf at Ship Island had already proceeded so far before any question as to the policy arose as to make it highly inexpedient to alter the original plans of the board in respect of that very important station." It is earnestly hoped that Congress will make adequate provision for the maintenance of this station, for the substitution of an adequate equipment at Hampton Roads and Sapelo Sound, in lieu of the temporary make-shifts adopted this summer, and for the establishment in Galveston Bay, or elsewhere on the coast of Texas, of a station for the protection of its extended coast line between Galveston and the mouth of the Rio Grande.

The municipalities most immediately concerned recognize the great value of these national quarantines, and earnestly desire that the machinery which will secure them against the introduction of infec-

tion from abroad, and thus against the risk of becoming the means of transmitting infection to other parts of the United States, shall be perfected and perpetuated. There is a partial exception to this remark in the case of New Orleans, where, although all the leading representatives of its commercial interests are known to be extremely desirous that infected vessels shall be required to proceed to the national quarantine at Ship Island instead of coming up the river to the Mississippi quarantine, to the great jeopardy of the population of the surrounding country on both sides of the river, the wishes of the community have been thwarted by the action of the State board of health, which has hitherto repelled all offers of aid on the part of the National Board looking to the reception and treatment at Ship Island of infected vessels bound for the port of New Orleans. This action of the State board of health of Louisiana has caused great dissatisfaction and alarm on the part of the people of the Mississippi Valley, who believe that there can be no adequate guarantee of the protection of the public health throughout the valley as long as infected vessels are permitted to enter the Mississippi River. This belief and the consequent distrust of New Orleans entertained by the health authorities of the States bordering on the river and its tributaries, are expressed in firm but temperate language in numerous articles of the daily press and in official ordinances of State and municipal boards of health. Attention is specially invited to two articles from the Memphis Appeal, of August 1 and ——, respectively, under the caption "Quarantine in New Orleans," and to "An Open Letter to his Excellency, the Chief Executive of the State of Louisiana," addressed to that officer August 14, 1880, by G. B. Thornton, M. D., and John Johnson, members of the State board of health of Tennessee. Copies of these several papers, marked B, are hereto annexed.

The immediate occasion for the course adopted by the authorities of Tennessee and Mississippi, as alluded to in these papers, was the arrival of the bark Excelsior at New Orleans after a detention of eleven days at the Mississippi quarantine, and the occurrence of a fatal case of yellow fever among the crew during the discharge of its cargo of coffee. As soon as it was clearly established that the case in question was one of yellow fever the vessel was ordered back to quarantine, where four other cases occurred on board said vessel, of which two were fatal.

While the State board of health of Louisiana has thus, in defiance of the demands of the health authorities of the neighboring States, whose interests are so vitally concerned, declined to accept the offer of the National Board to receive and disinfect vessels clearing for New Orleans from infected ports, the authorities of all the ports between that city and Cedar Keys have signified their purpose to direct all infected vessels to report to the national quarantine at Ship Island before proceeding to their ports of destination.

In like manner the health authorities of the ports of the South Atlantic coast have solicited the establishment of a national quarantine in Sapelo Sound, and have instructed pilots to make inquiry, in all cases before boarding, as to the sanitary condition of the vessels destined for these ports, and to order "all vessels having sickness on board, or on which serious cases have occurred during the voyage, to proceed at once to the national quarantine at Sapelo."

The period of danger with reference to the introduction of yellow fever into the United States being, for the present season, well-nigh past, measures have been taken to discontinue operations at Sapelo Sound, and to reduce the force at Ship Island by relieving the present quarantine officer, Dr. Martin, who will be placed on the reserve list, and by directing Dr. Collins, late supervising sanitary inspector at New Orleans, to take charge of the public property on the island and to perform the duty of boarding and inspecting all vessels which may require it during his stay at that station. These measures have been taken in conformity with the suggestions and advice of Dr. Bemiss, a member of this Board, who has had the general supervision of its work in New Orleans and the surrounding country, and especially of the operations at the Ship Island quarantine. It should be borne in mind that yellow fever prevails in Havana during every month of the year, and that in mild winters the ports of the gulf coasts would probably not be exempt from the risk of a general infection if infected vessels were permitted to come to their wharves.

As connected with this arrangement for the winter, it may be stated that the aid heretofore extended to the health authorities of the towns on the gulf coast, between New Orleans and Pascagoula, has been suspended by placing on the reserve list the several sanitary inspectors at the ports of Hancock and Harrison Counties, on the Mississippi Sound.

INTERSTATE QUARANTINE.

In conformity with the views and purposes expressed in former reports of this Board, especially in the last quarterly report, the systematic inspection by paid agents of the Board at New Orleans, Vicksburg, Memphis, and Cairo, of vessels bound for various points on the Mississippi above New Orleans, and at Bayou Sara of vessels proceeding up the Red River, has been in successful operation during the summer under the constant supervision and direction of Dr. R. W. Mitchell, of Memphis, a member of this Board, and has been productive of the best results in giving confidence to other communities otherwise disposed to establish a rigid quarantine against the city of New Orleans on the bare suspicion of the existence of a single case of yellow fever in that city.

Exception was taken by the State board of health of Louisiana to an order alleged to have been given by an agent of the National Board, prohibiting the shipment to Mobile and to ports and places in the State of Mississippi of coffee from the infected bark Excelsior, on which, as just recited, several cases of yellow fever had originated shortly after the handling of its cargo at the city wharves. In point of fact the order in question emanated from the health authorities of Mobile and Mississippi, and was promulgated by their authority by Dr. Rice, an agent of the National Board, with the simple view of warning shippers that the article, if shipped, would be declared contraband of quarantine, and would not be permitted to enter the ports referred to. The State board of health of Louisiana had previously been informed by an official communication (copy hereto attached, marked C) from the president of this board that the latter disclaimed any authority to interfere with the shipment of goods, or even to make inspections of steamboat freights, except at the request of the owners or captains of the boats, and the State board had, through its president, united in an earnest application to the National Board to make these inspections, not only of river craft, but also of railroads leading out of the city, on the ground that both were essential to give confidence to other communities. It is, indeed, true that the value to New Orleans of these inspections, in securing it from needless restrictions on its commerce, which otherwise would have been imposed by neighboring States, can scarcely be exaggerated.

An order to suspend these inspections by the 15th September for railroads, and by the end of the month for river craft, had been issued, when an earnest request was made by the authorities of Vicksburg, Miss., to reconsider the order so far as the river inspection service at that station was concerned. In compliance with this request the period was extended to the 15th October. The request was based upon an apprehension that an alarming outbreak of serious disease near Point á la Hache, in the vicinity of the Mississippi quarantine, might prove to be an epidemic of yellow fever, which had originated in the cases occurring on the infected bark Excelsior. Such, indeed, was the deliberate opinion of several competent physicians, and especially of Dr. G. M. Sternberg, of the United States Army, who has had a large experience in yellow-fever epidemics, and has made a special study of the character of the disease both in the United States and in Havana, as a member of the yellow-fever commission appointed by this Board to proceed to the latter place in order to investigate the nature of the fever in a locality where it has become permanently endemic. When this opinion was made known, a communication was addressed to the State board of health of Louisiana, by Dr. S. M. Bemiss, the local representative of the National Board in New Orleans, offering pecuniary aid to prevent the spreading of the disease. This offer was declined on the ground that there was no yellow fever in or near the city; whereupon, at the request of the citizens of New Orleans, a further investigation was made by a commission consisting of Dr. J. P. Davidson, of the State board, Dr. Sternberg, U. S. A., and Dr. J. D. Bruns, of New Orleans. A majority of this commission came to the conclusion that the disease in question was not yellow fever, but a severe form of malarial fever, probably caused by miasma from rice fields in the vicinity. From this opinion Dr. Sternberg has expressed his dissent, reiterating the emphatic expression of his belief that the disease, which is mainly confined to young persons, is a mild form of yellow fever; and in this opinion Drs. Bemiss and Mitchell, members of this Board, who have had a large experience in connection with yellow-fever epidemics in New Orleans and Memphis, have officially expressed their concurrence. Their reports and other papers relating to this question have been published in the Bulletin, No. 16, a copy of which is hereto appended, marked D. It should be added that shortly after the reception of these reports the existence of an undoubted case of yellow fever within the limits of the city was announced in an official telegraphic dispatch to this office, signed by Dr. Bemiss and by Dr. Loeber, acting president of the State board; and Dr. Bemiss, in an official communication dated October 6, states that other cases, probably as undoubted as this, has occurred in and near the city.

AID TO THE DISTRICT OF COLUMBIA.

Information having been received at this office from Havana, Cuba, of the sailing from that port on the 24th August of an infected vessel, the Emma J. Lewis, bound for Washington, the same was promptly communicated to the health officer of the District, Dr. Smith Townshend, and on his application for aid to prevent the introduction of yellow fever into the District of Columbia a requisition was made for the sum of $250 to enable him to employ a sanitary inspector with authority to stop at the District limits all suspected vessels.

It should be added that the vessel in question has not arrived within the jurisdiction of the District, nor is it known that she has appeared within the capes of Virginia.

A statement of the expenditures of the Board for the quarter is herewith respectfully submitted.

J. L. CABELL, *President.*
T. J. TURNER, *Secretary.*

To the Hon. JOHN SHERMAN,
Secretary of the Treasury.

Statement of the expenditures of the National Board of Health for quarter ending September 30, 1880.

On what account.	Month of July, 1880.	Month of August, 1880.	Month of September, 1880.	Total for quarter ending September 30, 1880.
Floating quarantine on Mississippi River	$4,001 05	$3,676 94	$2,310 40	$9,988 39
Ship Island quarantine	5,222 57	1,285 08	5,229 63	11,737 28
Blackbeard Island quarantine	2 12	332 56	2,432 74	2,767 42
Elizabeth River quarantine	....	1,762 50	555 25	2,317 75
Aid to Pensacola, Fla	2,075 06	545 67	574 90	3,195 63
Aid to Pascagoula, Miss	....	....	97 58	97 58
Aid to Hancock County, Mississippi	....	....	319 35	319 35
Aid to Harrison County, Mississippi	....	28 50	325 20	353 70
Aid to State board of health, Louisiana	....	665 00	825 00	1,490 00
Aid to State board of health, Texas	....	....	125 00	125 00
Aid to Charleston, S. C	....	40 20	....	40 20
Havana commission	....	662 30	....	662 30
Pay and expenses inspectors at Havana, Memphis, &c	1,861 00	1,530 05	1,678 10	5,069 15
Special scientific investigations	82 30	144 40	623 03	849 73
Pay and expenses members of the Board	634 05	1,102 36	822 79	2,559 20
Storage of tents, &c	103 50	157 25	....	260 75
Printing of the Bulletin of National Board of Health	1,103 03	596 86	448 00	2,147 89
Printing of blanks, &c	9 52	46 74	116 39	172 65
Pay of clerks, messengers, &c	1,508 03	1,483 83	1,458 53	4,450 39
Rent, light, and fuel	105 40	....	107 00	212 40
Telegrams	12 28	48 09	35 74	96 11
Furniture, stationery, &c	748 30	17 50	....	765 80
Miscellaneous expenses National Board of Health	52 68	130 77	59 41	242 86
Total for the quarter ending September 30, 1880	17,520 89	14,256 60	18,144 04	49,921 53
From the date of organization of the Board to June 30, 1879, there was expended				9,146 41
From June 30, 1879, to June 30, 1880, there was expended				266,762 16
Total amount expended by the Board from date of organization				325,830 10
Total amount expended at Ship Island quarantine, including purchase of boats, construction of wharves and buildings, and maintenance of same, has been				30,726 17
Total amount expended for purchase of boats, establishing stations, and maintenance of the Mississippi River inspection service				50,526 50

A.

GAUGING OF PUBLIC SEWERS.

[Report of George E. Waring, jr.]

NEWPORT, R. I., *July* 19, 1880.

SIR: Appended hereto please find my report on the gaugings of sewers in different parts of the country, which have been carried on during the past year under my direction by the order of the National Board of Health.

Respectfully, yours,

GEO. E. WARING, JR.

Dr. T. J. TURNER,
Secretary National Board of Health.

The purpose of these gaugings was to determine the size of conduit needed for the removal of the greatest amount of sewage matter produced by given populations; in other words, to determine the degree to which it would be safe to reduce the sizes of public sewers in cases where the object is only to remove the foul sewage matters of households, manufacturing establishments, public institutions, &c. No attempt was made at an elaborate scientific examination of the flow, beyond what was necessary for this one purpose.

It has been almost the universal custom up to this time, in planning a system of sewers for a town, large or small, to regulate the sizes of the sewers with a view to the removal not only of domestic and manufacturing wastes, but also of a considerable amount of rainfall. This custom is open to several objections:

(1.) Sewers large enough for the removal of storm-water are so much too large for domestic sewage that they must inevitably be foul and in a bad sanitary condition, except when flushed by storm-water. As storm-water is often withheld for many weeks together, and often at a season when the decomposition of deposits in the sewer is most active and injurious, this condition constitutes a very grave sanitary defect.

(2.) While the cost of storm-water sewers may be borne with tolerable ease in a city where the whole abutting property is built up, the distribution of such a charge among the scattered inhabitants of a more village-like town, where lot fronts are often very much larger than in the city, constitutes a serious burden—so serious, indeed, as to be in many instances prohibitory.

(3.) Aside from the foul air produced in the sewers themselves, the decomposition of the filth which accumulates in the catch-basins, by which street-water is admitted to the sewers, is often a source of most serious offense, if not of danger.

(4.) By extending the underground removal of storm-water to the very crests of the elevations of a town, the gutter flow, even at points where it could cause no inconvenience, is so much reduced as to prevent the cleansing of the gutters, which would otherwise be effected with each storm.

So serious are the objections above cited, that I have found in more than one case serious opposition to the construction of sewers on the part of local sanitary authorities. In Baltimore, for example, where the removal not only of surface water, but of the liquid wastes of households, is effected by surface drainage only, a very influential portion of the community strenuously resists all projects for sewerage, because of the advantage they believe now to be derived from the cleansing effect of storm-water flowing through the streets.

It seems to me more than questionable whether it would not be better to preserve the surface removal of rain-water in all parts of the town where its accumulation would rarely amount to a serious interference with the use of the streets, and where injury to private property is not to be apprehended. This would enormously reduce the length and consequently the cost of the storm-water system, and would at least confine to certain limited localities the objectionable features which are now so prominent.

There seems to be good ground for the belief that if the sizes of sewers can be adjusted to the removal of foul wastes only, not only will their condition be very much improved, but their cost will be so vastly reduced as to bring their advantages within the reach of the smallest communities.

As the most important step in determining the practicability of the changes above indicated, the National Board of Health commissioned me to institute such a series of gaugings as would determine the actual pipe capacity required. Formulæ in use among engineers would lead to substantially the same result with actual gaugings; but their educational effect would be less marked, because calculations based upon scientific formulæ are less readily comprehended by the average municipal ruler.

In pursuance of the instructions of the Board, I have instituted the following gaugings:

a. A sewer in Madison avenue, in New York, having, with its branches, a total length of about 7,000 feet, and occupying a district about half built up with houses of good class.

b. A sewer in a single street in Providence, R. I.

c. A sewer with a single short branch in Burlington, Vt.

d. Six sewers in a closely-built part of the city of Milwaukee, Wis.

e. The sewers draining the New York State Lunatic Asylum, at Poughkeepsie.

f. A characteristic sewer in the city of Poughkeepsie, N. Y.

g. The sewers draining the Massachusetts Hospital for the Insane, at Taunton, Mass.

h. A large sewer in Saint Louis, Mo.

The total result of these gaugings affords a very fair average result, covering a sufficient variety of conditions, upon which I submit the following summary of the facts developed:

Madison avenue sewer, New York.

This gauging was intrusted to Stevenson Towle, esq., civil engineer, the engineer in charge of the sewer department of New York, who kindly consented to make the investigations. Unfortunately, his other occupations did not enable him to complete the work, and I am only able to say that the greatest flow of the Madison avenue sewer was discharged through a notch (in a weir) 4 inches wide, which it filled to a depth of 3½ inches.

Providence, R. I.—Pine street sewer.

This investigation was made by J. A. Judson, esq., civil engineer, whose report may be summarized as follows: The total length of this sewer is 1,391 feet. Its grade varies from 0.86 per 100 to 4.18 per 100. The district which it drains contains 60 houses, all of which are residences, and 41 of which are connected with the sewer. The gauging in this, as in all other cases, was taken at the time of the greatest use of water of the week, in this case on Monday morning, between the hours of 8 and 11. The depth of flow was measured at intervals of 15 minutes. The population tributary to the sewer numbers 267. The result showed that the greatest flow of sewage reached a depth of 0.4375 inch in the 12-inch sewer. In the reducer, which brought the current into a channel having a radius of 3 inches, the greatest depth of flow was 0.875. A pipe 1.84 inches in diameter, running full at the same velocity, would carry the greatest flow of sewage from this population of 267.

Burlington, Vt.—College street sewer.

This gauging was made by A. R. Dow, esq., city engineer. The total length of this sewer and its branch is 2,790 feet. Its grade varies from 0.435 per 100 to 3.39 per 100. The district which it drains contains 85 houses, of which 54 are connected with the sewer. Forty-nine of these are dwelling-houses, and 5 are stores and shops. The population tributary to the sewer embraces 325. The gauging was

taken at intervals of 15 minutes from 7.30 a.m. to 10.30 a.m. The result showed that the greatest flow of sewage reached a depth of 1.2 inches in a pipe of 3-inch radius. A pipe 2.25 inches in diameter, running full at the same velocity, would carry the greatest flow of sewage from this population of 325 persons.

Milwaukee, Wis.

These gauges were made by A. H. Scott, esq., civil engineer, of the city engineer's office, in the sewers of Detroit, Martin, Chestnut, Biddle, Wisconsin, and Huron streets.

The gaugings of the Huron street sewer are of especial significance. This sewer is 42 inches in diameter. The grade of the sewer at the point where the gaugings were taken was about 1 in 400. The area tributary to the sewer is about 70 acres, all nearly level, closely built, containing 500 houses, mostly dwellings, and a total population of 4,035. One hundred and thirty-two of the buildings are not connected with the sewer; the remaining 368 buildings contain a total population of 3,177, all of whom are tributary to the sewer. There are several hotels, saloons, small factories, and livery stables; so that the district is fairly representative of an average city area.

The greatest flow in the main sewer on "washing day"—the greatest flow of the week—attained a depth of 6 inches, the diameter of the sewer being 42 inches.

The channel being reduced to a diameter of 10 inches, the greatest depth of the flow was 4.5 inches. Reduced to a diameter of 8 inches the depth remained the same—4.5 inches. Reduced to a diameter of 6 inches, it reached a depth of 5.5 inches.

The influence on the velocity of the stream by increasing its hydraulic mean depth is illustrated by the following figures:

"Forty-two-inch sewer, 6 inches deep; cross-section of stream, 121.3 square inches.

"Ten-inch sewer 4.5 inches deep; cross-section of stream, 33.1 square inches.

"Eight-inch sewer 4.5 inches deep; cross-section of stream, 27.7 square inches.

"Six-inch sewer, 5.5 inches deep; cross-section of stream, 27.14 square inches."

Poughkeepsie, N. Y.—Hudson River State Hospital.

This gauging was made by J. A. Judson, esq., civil engineer. This institution uses a daily average of about 80,000 gallons of water. The entire waste, including boiler-house, laundry, and kitchens, is discharged through a main sewer 12 inches in diameter. Its least fall is 1 foot in 100 feet, and its *average* fall is about 5 feet in 100 feet, so that its contents flow at high velocity. On the day of examination, January 17, 1880, the hospital had 301 inmates—241 patients and 60 employés. The flow was measured between 9 a. m. and 12 m., at intervals of 10 minutes. The maximum discharge took place at 9.30. The channel was reduced to a diameter of 6 inches, and the measurements were made with a thin strip of wood set edgewise to the current. The maximum flow attained a depth of 3.25 inches. At 9.20 it had attained 2.50 inches, and at 9.40 it reached only 2.75 inches. At 11.20 it again touched 3 inches.

A concise statement of the case would be this: 301 persons consuming 80,000 gallons of water per day, being 265 gallons per head, produced an amount of sewerage sufficient at its maximum to create a stream in a 6-inch pipe 3¼ inches deep.

The greatest flow (3.25 inches) would have been carried by a pipe 4.25 inches in diameter, running full at the same velocity.

Poughkeepsie, N. Y.—Market street subdistrict sewer.

This gauging was conducted by J. A. Judson, esq., civil engineer. This is a 15-inch vitrified pipe sewer, draining Church street, Noxon street, and a part of Market street. The total length of the sewer delivering at the point of gauging is 2,766 feet. The number of houses tributary to the sewer was 39, and the population 426. The greatest flow of their sewage, measured in a pipe 6 inches in diameter, was 2.25 inches. It might all have been carried in a pipe a trifle more than 3 inches in diameter.

Taunton, Mass.—State Lunatic Hospital.

The gaugings at this hospital were conducted by J. A. Judson' esq., civil engineer. This hospital is situated about one mile south of the city, on elevated ground, near Mill River. The building is large and is abundantly supplied with water from its own steam-pumping works, about 40,000 gallons per day being used for all purposes, including the laundry. The main sewer is a 10-inch iron pipe. This sewer carries away, in addition to roof water, the entire waste of the establishment with the exception of the laundry, which delivers through an independent sewer to be referred to hereafter.

The flow of the 10-inch sewer was reduced to a diameter of 6 inches, and gaugings were taken at the usual intervals of 10 minutes during the time of the greatest use of water in the establishment. The summary of the report shows that the population occupying this hospital, 659 in number, produced sewage matter from all sources, except the laundry, sufficient to cause a depth of flow in the 6-inch pipe of only 1¾ inches at the greatest. A sewer 3 inches in diameter (2.96) would, with a flow of the same velocity, discharge the greatest amount yielded by this population.

A separate investigation of the flow of the laundry sewer showed very great variations, due to the fact that sometimes one and sometimes all of the large washing-machines, five in number, were emptied suddenly, producing a great momentary increase. The minimum flow between 9.30 and 11.30 a. m. was less than 1 inch in depth (.875). At 10.40 a. m. the maximum flow was produced by the simultaneous emptying of all the machines. This raised the depth of water in the 6-inch pipe to 2¼ inches. In 10 minutes it had fallen to 1¼ inches. The maximum flow would have been carried at the same velocity through a pipe 3.50 inches in diameter.

The entire maximum flow of the two sewers would have been carried, supposing the velocity to be the same, in a pipe 4.58 inches in diameter. (It is worthy of notice that it has been seriously proposed that the State of Massachusetts should pay one-half of the cost of a large 5-foot sewer because of its contributing to the sewage of the town this small stream, which would be amply accommodated by a 6-inch pipe.)

Saint Louis, Mo.—Compton avenue sewer.

This gauging was made under the direction of Robert Moore, esq., civil engineer, commissioner of sewers of Saint Louis. The sewer drains an area containing 1,370 houses, occupied by a population of 8,200. The total number of water-taps was 1,391. The diagrams show gaugings taken every hour from 6 p. m., Monday, March 15, to 11 a. m., March 16, and from 8 a. m., March 19, to 8 a. m., March 23. These gaugings are averaged to make a typical day, in which, beginning at midnight with a flow of 75.32 cubic feet per minute, the flow was reduced to 70.26 cubic feet per minute at 2 a. m.; then it went 71.87 cubic feet per minute at 6 a. m., 130.26 cubic feet per minute at 11 a. m., 123.86 cubic feet per minute at 3 p. m., and steadily declined from this time until midnight, when the flow was 75.15 cubic feet per minute. The sewer is 7 feet 3 inches in diameter. It was obstructed by a dam, into which was built a 12-inch vitrified pipe sewer, which was continued for a length of 20 feet. The gaugings were taken simultaneously at three different points, the average of these being the assumed depth through the 20 feet of 12-inch pipe. The greatest depth reached in this pipe was less than 7 inches (.5833 foot). Flowing at the same velocity, the whole stream would have been carried by a sewer a trifle more than 9 inches in diameter.

A computation of the amount of flow as compared with the population makes it evident that the sewer must have received a very large amount of ground water, for the total flow (over 1,000,000 gallons per day) amounted to more than 130 gallons for each member of the population, which, in a district having only about one water-tap to each house, would be an impossible amount. It is usual to estimate a maximum daily use for domestic purposes of about 33 gallons per head of population. Deciding the total flow by this amount, we might assume that the 12-inch pipe used in this instance, carrying, at its maximum, less than 7 inches in depth of water, was doing the amount of work that would be required for removing the sewage only of a population of over 30,000, supposing the sewers to be absolutely tight so that only household wastes should enter them. This last example is, from its extent and from the minuteness with which its details were worked out, the most important of the series. It seems to me to furnish a conclusive argument—an argument fully sustained by all of the other gaugings—in favor of the safety of depending upon very small conduits for the removal of the dry-weather flow of sewage of cities and towns. It shows conclusively that the commission of the National Board of Health which recommended the system since carried out in Memphis—lateral sewers 6 inches in diameter, main outlet 20 inches in diameter—for a prospective population of 60,000, provided a wide margin for contingencies.

The result of these investigations cannot fail to be of the greatest practical value, especially in the case of the smaller towns, where the cost of constructing the usual storm-water systems is so great as to be prohibitory. Incidentally, the advantage to all towns, large or small, of adjusting the sizes of the sewers to the actual work of removing foul wastes must be regarded as most promising.

NOTE.—Robert Moore, esq., sewer commissioner of Saint Louis, has formulated a table based on the actual gaugings of the Compton avenue sewer (Saint Louis). He says, concerning it:

"When the water is running at the rate of 1,250 gallons per house per day, which, it is supposed, will never be exceeded, the depth of flow will be equal to three-quarters the diameter of the pipe.

"This rate is 23 per cent. greater than the *maximum* rate of the typical day in Compton avenue, and 60 per cent. greater than the average rate of the same day, and seems to me to be as great as need ever be counted on from house drainage alone."

It is at least four times as great as the usual consumption of water.

I have also received from him the results of the gaugings of the Ohio avenue sewer in Saint Louis.

The sewer is 7½ feet in diameter (necessarily very large, because of large amounts of storm water which it was constructed to remove). Its district contains 120 houses, with a population of 760. The *greatest* discharge of sewage from this population filled a 6-inch pipe *to a depth of only 1½ inches.*

B.

QUARANTINE IN NEW ORLEANS.

[From the Memphis Appeal, August 1, 1880.]

In what the Appeal has had to say, from time to time, concerning the relations of New Orleans to the health of her sister communities in the Mississippi Valley, one motive, and only one, has inspired its utterances. New Orleans is as truly our metropolis, our representative city, as is Chicago of the great northwest, as New York is of the Atlantic States, as Paris is of France. Nothing can well be more puerile or absurd than insinuations and charges of rivalry, jealousy, a desire "to abridge the liberties and destroy the commerce" of the Crescent City. This is the sheerest nonsense. There can be no rivalry between her and any other point on the river south of Saint Louis. And if she will only be true to herself, if she will utilize the magnificent opportunities lying within her grasp, and, foremost of all, if she will purge herself from the paralyzing charge of infection, she may readily outstrip the City by the Bridge, and soon dispute with Gotham the claim to be *the* representative city of the American continent.

But this last condition is indispensable. Indispensable not only to such preëminence, but to her existence. She must make every effort to free herself from the taint of yellow fever, whether engendered within her own limits or imported from abroad. This the rest of the valley has a right to demand, and believes it has the power to enforce. And if Memphis assumes the initiative in the exercise of this power, surely the histories of 1867, of 1873, of 1878, and of 1879, to say nothing of our labors, expenditures, and sacrifices for the sanitary regeneration of our city, are the sufficient warrant for such assumption.

What is asked of New Orleans is neither unjust nor onerous. It is no more, if so much, in proportion, as the other communities in the valley impose upon themselves. Let her comply with this request in good faith; let her board of health and sanitary association continue in the good work they have been and are doing in internal sanitary reform, and then, if yellow fever makes its appearance, she will be free at least from the moral responsibility for it, and will receive sympathy and aid instead of execration and hatred.

What she is asked to do is simply to exclude vessels from the infected ports from the Mississippi River during the dangerous season. Not to abandon her trade or commerce in the slightest degree; not to forego the receipt or handling of a single sack of coffee or bunch of bananas. Only to compel vessels clearing from ports infected by yellow fever to lighter their cargoes to the city and receive their return cargoes in the same way. We care not whether this is done at the Mississippi quarantine station, at Port Eads, or at Ship Island, only so that it be done, and so done as to preclude the possibility of the cargo or crew of the vessel carrying infection into the city, as it was from the Valparaiso in 1873, from the Emily B. Souder in 1878, and as is claimed to have been the case with the Excelsior within the past twenty days. The facts are that, hitherto, the Louisiana health authorities have failed to keep yellow fever out of New Orleans; that, outside of New Orleans, no one believes they can keep it out so long as their quarantine station is located in the river within a few hours of the city, in the direct course of all river travel, and with excursion boats bringing passengers and crews from detained vessels direct to the city, mingled with hundreds of excursionists. These are undisputed facts. As to their remedy, we shall have something to say in the future.

[From Memphis Appeal, August, 1880.]

In previous articles under this caption the Appeal has sufficiently outlined the relation of New Orleans to the rest of the valley, so far as regards the introduction and spread of epidemic disease; the charges of hostility, rivalry, jealousy, in connection with outside quarantine restrictions, have been shown to be utterly baseless, and the attitude of the various elements composing the New Orleans community toward yellow fever has been proven from their own statements to be one of indifference, not to say deception and concealment. The demand of the valley outside of New Orleans has also been set forth clearly and succinctly, and it only remains now to indicate a feasible method of complying with that demand in order to exhaust all that need be said on this subject. New Orleans is asked to forbid entrance into the Mississippi river of vessels from infected ports during the dangerous season. So far, after years and years of trial, the Louisiana State board of health, with its quarantine station seventy-five miles below the city, has failed to prevent the introduction of yellow fever into New Orleans, and thence throughout the valley. No matter how honestly and scientifically that station is conducted, the communities outside of New Orleans believe that it will still prove a failure in the future as it always has in the past. Aside from other considerations, the west is now looking to the Mississippi River as an outlet for her grain, and cannot afford to have this outlet closed for three or four months in the year (and at the time when most needed) by the existence of a pestilence in New Orleans, and of a fleet of infected ships moored in the river, with deserting crews and escaping passengers carrying contagion into a thousand unsuspected quarters. The remedy lies in transferring the quarantine station to some point outside the river, and in maintaining within the river itself a simple inspection station, at which vessels will be obliged to show that they are not from an infected port and are free from contagious or infectious disease within themselves. Having established these points at the cost of a few minutes delay, such vessels might then be safely permitted to proceed up to the city. But if from an infected port, or with contagion or infection on board, such vessel should be refused permission to come further up the river under any circumstances. This disposes of the only objection urged to the proposed plan, namely that the Louisiana State board has no right to order a vessel to any outside quarantine station, or to forbid her entering the river. This last the board certainly has a right to do, unless the vessel can clearly establish her harmless character, and the mode of doing so is entirely within the province of the board. A simple solution of the whole matter lies in the adoption of the Ship Island quarantine station by the Louisiana health authorities. Here, with a safe harbor, there are ample accommodations for the transfer of cargo, commodious warehouses, suitable facilities for the treatment of an infected vessel and cargo, and spacious quarters for the temporary detention of the compromised, but healthy passengers and crew, as well as hospital accommodations for the sick. Considered merely from the economical standpoint there is everything in favor of Ship Island as compared with the Mississippi quarantine station. Cargoes can be lightered to New Orleans through the lakes and canal, and vessels be loaded in quarantine and returned to commerce with the minimum of detention. The cost of lightering a ship's cargo from Ship Island is but little more than the amount now paid for towing up the river to New Orleans. Taking into consideration the time saved in returning the vessel to commerce, the balance in favor of Ship Island is at least 20 per cent. on the average as compared with the Mississippi River route. In such a case as that of the Excelsior, which must be detained thirty days after the last case of fever, the balance is immensely greater. All this without computing what a single case of fever at her levee has cost New Orleans in this one instance. It should be remarked, too, in this connection that the removal and expense of cargo by lightering is the most efficient disinfection. It is by this means New York protects her port while imposing no restriction on commerce. Coffee from infected ships is freely admitted into New York, but only by lightering from the lower bay. The vessel is detained and cleansed, after her cargo is all removed, before she is allowed to come to the city. The health officer of that city would no more think of allowing a vessel like the Excelsior to go up to an East River pier to discharge her cargo than he would entertain a proposition to poison the waters of Croton Lake. Indeed, since the Excelsior affair all vessels from southern ports, whether such ports are infected or not, are compelled to lighter their cargoes from Robin's reef up to the city. If such precautions are necessary in New York, how absolutely imperative should they be regarded in a semi-tropical city like New Orleans. The distance from the mouth of the river to New Orleans, which vessels must be towed against the current, is about one hundred and thirty miles; from Ship Island to the city, through the Rigolettes and lake, is about eighty miles. Vessels direct from European ports for the mouth of the river pass only a short distance south of Ship Island, and then have to tow up the one hundred and thirty miles, exposed to detention at quarantine and the risk of infection from other detained vessels. We are satisfied, from the communications we are in receipt of, that a larger number of merchants in New Orleans are in favor of some such change as herein indicated than the State board of Louisiana has any conception of. It would not be amiss for our chamber of commerce to look into this subject, and, after investigation, to take such action as seems proper to strengthen the hands of those who are anxious to preserve the health of the valley while fostering and building up its material interests. We are all in the same boat in this matter, as in many others; and whatever is good for Memphis is good for New Orleans, and vice versa. The Appeal trusts its brethren of the Cresent City will accept its remarks and strictures in the spirit in which they are made; that is, for the best interests of the whole southland, of which New Orleans is at once the crown and queen.

[From the Memphis Avalanche, August 15, 1880.]

WHY THE BRAKES WERE PUT DOWN.—CAUSE OF THE QUARANTINE AGAINST NEW ORLEANS.—AN OPEN LETTER TO THE GOVERNOR OF LOUISIANA.

Dr. G. B. Thornton, president of the Memphis board of health, and member of the State board of health, and Hon. John Johnson, member of the State board of health, have issued an "open letter" to the governor of Louisiana, explaining the cause of the action of Tennessee relative to enforcing quarantine regulations against New Orleans. It will not fail to be read with interest, and is as follows:

An open letter to his excellency the chief executive of the State of Louisiana.

MEMPHIS, TENN., *August* 14, 1880

SIR: In view of recent public and official strictures upon the Tennessee State board of health, on account of its order issued July 14, concerning the sanitary supervision of intercourse with New Orleans

during the existence of a threatened danger to the public health of the Mississippi Valley, it seems fitting that the representatives of the State board resident in this city, and who are largely responsible for that order, should take some cognizance of those criticisms.

It ought to be entirely unnecessary to say that nothing but the kindliest feelings do or can exist toward New Orleans from Memphis and the State of Tennessee. We believe our interests, if not identical, are at least so much in common, that whatever helps or hurts New Orleans, helps or hurts Memphis and the rest of the valley. If, however, New Orleans brings harm to herself by neglecting proper precautions (for example, in the admission of vessels from ports infected with yellow fever), then the law of self-preservation demands that the rest of the valley, which has been so often scourged through New Orleans, shall take such steps as may be needed to confine that harm, if possible, to the community which has permitted it through negligence or indifference.

While such steps may be taken reluctantly, and with regret that the necessity for them exists, the authorities charged with the protection of the public health cannot hesitate to do their sworn duty. It was with this conviction that the order in question was issued—an order which, it should be noted in passing, applied mainly to articles described in the printed rules and regulations of the Louisiana State board of health as being dangerous under such circumstances as those attending the Excelsior affair, and which that board declares should be subjected "to obligatory quarantine and purification." (See "Rules and Regulations Louisiana State Board of Health, 1880," page 8.)

That the order of the Tennessee board of health was wise, timely, and beneficent in its workings there is ample evidence, aside from any interested testimony of the board itself. It is not too much to say that its prompt publication arrested a fast-growing tendency to panic and preparation for local "shot-gun" quarantines, begotten of the alarming announcement of an outbreak of yellow fever on a coffee ship in New Orleans, the details of which were recited at a meeting of the Louisiana State board of health, on July 12, and upon the published report of which the Tennessee order was based. Had the order been longer delayed, or not issued at all, past experience forces the conviction that travel would have been impeded and traffic more or less completely interrupted.

That the requirements were not made more stringent, and did not impose greater restrictions upon commercial and personal intercourse between New Orleans and the State of Tennessee is due solely to the confidence reposed in the inspection service of the National Board of Health, both at New Orleans and throughout the valley. In the absence of this agency it would have been the imperative duty of the State board, and of local boards throughout the State, to recommend the absolute prohibition of all freight, and a quarantine of observation for all compromised passengers, from New Orleans, until a sufficient period had elapsed to determine whether the five cases and three deaths from yellow fever among the crew of the Excelsior, and her 3,600 sacks of presumably infected coffee, were to be the seeds of another epidemic, as the single case from the Valparaiso was the seed of the epidemic of 1873, with its harvest of 16,000 cases and 4,000 deaths in Shreveport, and Memphis, and Montgomery, Ala., and Calvert, Tex., and other places; or as the single case from the Emily B. Souder was the insignificant and uncared-for beginning of the wide-spread pestilence of 1878.

It is submitted to your excellency, and to the public, that the inconvenience and pecuniary losses caused by this admission of a vessel from an infected port into the port of New Orleans in midsummer, bear no comparison to the cost (aside from the question of human life) which similar action has entailed in the past.

How far the State board of health of Louisiana is to be credited with the good fortune that an epidemic has not yet resulted from the Excelsior it is not our province to discuss. But it is entirely proper to assert, in the light of what has since occurred, that the orders of the State boards of health of Mississippi and Tennessee averted a panic, prevented the interruption of travel and traffic, and restored confidence throughout the valley of the Mississippi in many communities which have not yet forgotten the history of the year 1878.

Very respectfully,

G. B. THORNTON, M. D.,
JOHN JOHNSON,
Members Tennessee State Board of Health.

The following circular has been issued by the State board of health of Tennessee relating to commerce with New Orleans:

OFFICE OF STATE BOARD OF HEALTH,
Nashville, Tenn., July 14, 1880.

Whereas one death from yellow fever, and two other cases, have occurred in New Orleans among the crew of the coffee ship Excelsior, from Rio de Janeiro; and

Whereas the history of said ship, as recited at a meeting of the Louisiana State board of health, held in the city of New Orleans on the 12th instant, conclusively shows that the vessel and her cargo are infected with yellow fever; that her infected cargo is now stored in a warehouse in that city; and that her captain, some members of her crew, and a large number of visitors, as well as the persons (seventy-five or more) who were engaged in and about said infected vessel in breaking out cargo, and in handling, draying, and storing her infected merchandise, are scattered throughout said city; and

Whereas this board is charged with the duty of protecting the public health of this commonwealth against the introduction of contagious and infectious diseases, and believes such introduction is now seriously threatened by the above-described condition of affairs at New Orleans, it is therefore hereby ordered—

First. That on and after the date of this publication no freight-car over any railroad, nor any steamboat or other water craft departing from the city of New Orleans after the 15th day of July, 1880, and until further orders, shall be allowed to enter the State of Tennessee nor to make a landing upon the borders of the State for the purpose of transacting any business whatsoever, unless said car, boat, or water craft shall present to the proper officers of this board a certificate from an officer or agent of the National Board of Health to the following effect:

(*a*) That said officer or agent of the National Board of Health has personally examined the freight of such car, or the cargo, passengers, officers, and crew of such steamboat or water craft, and has satisfied himself of the freedom from infection of said vehicle and its contents (persons and things).

(*b*) That the freight or cargo comprises none of the following articles of the list recommended by the Louisiana State board of health to be subjected to obligatory quarantine and purification, to wit: Clothing, personal baggage, and dunnage, rags, paper, stock, hides, skins, feathers, hair, and all other remains of animals; cotton, hemp, woolens, and coffee; nor any of the following additional articles, which are hereby declared contraband of quarantine in this State, to wit: Second-hand bedding, clothing, upholstered furniture, and textile fabrics; moss, jute, and "excelsior"; tropical fruits and productions.

Second. That any of the articles above enumerated may be shipped as freight from New Orleans, and transported through the State of Tennessee by rail, if carried in close box-cars, securely locked, and in charge of an officer or agent of this board. The expenses of such officer or agent shall be defrayed by the railroad transporting such goods.

Third. That this order shall be enforced on the railroads at the southern State line by the officers of the board appointed for such purpose; and at Memphis, and elsewhere upon the Mississippi River, by the wharf-master, or other duly authorized officer. The penalties prescribed by law for the violation or infraction of the orders of this board will be rigidly enforced in carrying out this order.

T. A. ATCHISON, M. D.,
President.
W. M. CLARK, M. D.,
Secretary.
E. W. COLE,
JOHN JOHNSON,
J. D. PLUNKET, M. D.,
J. M. SAFFORD, M. D.,
E. M. WIGHT, M. D.,
Members.

The following circular, relating to the same subject as the preceding, has been issued by the State board of health of Mississippi:

OFFICE OF MISSISSIPPI STATE BOARD OF HEALTH,
Jackson, Miss., July 16, 1880.

Whereas the bark Excelsior, from Rio de Janeiro, laden with coffee, having arrived at New Orleans infected with yellow fever; and

Whereas her cargo is now stored in a warehouse in the latter city, and it is said a number of persons who were engaged on and about said bark in unloading, draying, and storing her cargo are now in said city, it is therefore hereby ordered—

First. That on and after this date, and until further orders, no car or train of cars departing from the city of New Orleans shall be allowed to enter this State, and no steamboat or other water craft from said city shall be allowed to land at any point in this State unless they have undergone an inspection by an officer of the National Board of Health, as is provided in the rules of said board, and are provided with a certificate of such inspection.

Second. That no part of the cargo of the bark Excelsior, and no freight from the warehouse in which said cargo is stored, shall be brought to any point in this State.

Third. That no persons from New Orleans shall be allowed to come to any point in this State unless they hold a certificate from an officer of the National Board of Health that they have not been exposed to infection.

Fourth. That the chief health officers of the counties and the municipal boards of health are charged with the enforcement of this

order, and any violation thereof will be punished as is provided by law.

WIRT JOHNSTON, M. D.,
ROBERT KELLY, M. D.,
Executive Committee.

Approved.
J. M. STONE, *Governor.*

C.

NATIONAL BOARD OF HEALTH,
Washington, D. C., August 10, 1880.

SIR: Your communication of July 30, relative to the action of Dr. C. A. Rice, concerning the shipment of coffee from the port of New Orleans to Mobile, and to ports and places within the State of Mississippi, was duly received. A reply thereto was deferred until a report could be received from Dr. Rice, to whom, on the receipt of your communication, a letter of inquiry was addressed. I now find that Dr. Rice had anticipated the receipt of that letter, and had on the 5th of this month addressed a communication to the acting governor of Louisiana, furnishing an explanation of his action in the premises. This Board has also received by yesterday's mail a copy of a letter addressed to you by Dr. Bemiss the 2d of August. These two communications by a member of this Board and by one of its agents are approved by the executive committee, and cover the ground so well as to supersede the necessity for any more elaborate explanation.

It appears so obvious that the orders of Dr. Rice, though expressed in perhaps unguarded language, could have no other significance than that which is explained in his communication to the acting governor, that I cannot withhold the expression of my great surprise that after the explanations heretofore given you of the principles which have invariably guided this Board in the management of the inspection service at New Orleans, and your avowed concurrence, you should now seek occasion to ascribe to it or its agents any disposition to assume powers which it has never exercised or claimed to possess, and for the attempted exercise of which it would have incurred a great responsibility.

In this connection I refer to my letter of June 15, and your reply thereto, dated June 25.

In the former, adverting to the fact that certain rules and regulations which had been submitted to the State board of health of Louisiana were not intended to be in aid of that board, but of the health authorities of places above New Orleans, I remarked:

"This Board claims no authority whatever to require the owner of boats to submit to such inspection, but in the interest of inter-State commerce it agrees to make these inspections and to furnish certificates in the case of steamboats, etc., *upon request of the owner, agent, or captain of such boats*, in the hope and belief that the certificates will prevent unnecessary interference above, and thus operate to the great advantage of New Orleans and the towns above. If the authorities of New Orleans choose to make it obligatory on the masters of boats clearing from that port to undergo these inspections, the National Board could have no objection, but it disclaims any authority to make such order itself. The rules in question being recommended for the protection of places above New Orleans will doubtless be enforced by the local authorities of such places. The special object for which they were submitted to the State board of Louisiana was to invite suggestions and criticisms before they were finally adopted by this Board itself, and I may remark that since they were thus submitted they have undergone some modifications. As adopted they will be printed in No. 50 of the Bulletin, a copy of which will be sent to you as soon as it comes out."

I further said:

"The executive committee directs me to say that while it has approved the appointment by Dr. Bemiss of three medical inspectors of railroads *nominated* by you, it does not clearly see that it was necessary or desirable to inaugurate railroad inspections in the absence of yellow fever, and inasmuch as a recent act of Congress in largely reducing the appropriation asked for by this Board, and restricting the use of a large part of the appropriation that was granted to the contingency of an epidemic, it will probably not be possible to continue this service beyond the present month (June) unless in the mean time cases of yellow fever should have occurred, in which contingency a portion of the appropriation not now available will become subject to the uses of the Board in extending aid to local and State boards of health."

In your reply, dated June 25, you say:

"The board of health authorized the president to express the conviction that the inspection of railroads is equally important with the river inspection service, and that both *are essential* to give confidence to the surrounding States and towns. The river inspection would be comparatively valueless without the railroad inspection, of which fact the faithful and efficient corps of inspectors have given many proofs. Dr. Rice, of the National Board (inspector), is in full accord with the State board on this subject. Up to the present moment the parties interested in the railroads and steamboats have yielded cheerful acquiescence to all the rules and regulations of the inspection service."

I have now to say that in no instance has this Board violated the principles avowed in my letter to you, and that if any of the inspectors at New Orleans whose salaries are paid by this Board, and most of whom were nominated by yourself, have transcended their authority, such act on their part will be disavowed and proper instructions promptly given.

I may observe, however, that even before receiving Dr. Rice's version of the matter the executive committee of this Board were of the opinion that the facts cited in your letter of July 30 did not sustain the interpretation you seemed desirous to put upon them. The committee was well assured that Dr. Rice could not possibly have meant to assert an authority which he had no means of enforcing, and the assertion of which would have been in direct violation of his instructions.

With reference to the last sentence of your letter, in which you complain of the action of Dr. Rice on the ground that it was taken "without the advice or co-operation of the lawful authorities to whom are confided by legislative enactment the conduct of the sanitary and quarantine affairs of the State of Louisiana," I have again to repeat the statement in my letter of June 15, that the whole of this river and railroad inspection service is intended for the protection of other States than your own, and is in aid of their health authorities. Incidentally, indeed, it was designed and has proved to be of great advantage to the commerce of New Orleans, since on the bare suspicion of a single case of yellow fever existing there the health authorities of the Mississippi Valley, and of other places in the South having commercial relations with that city, have declared that they will maintain a strict quarantine against it unless the inter-State commerce be carried on in accordance with the rules of the inspection service. These authorities have it in their power to protect their towns by a very simple and effective machinery. This Board has induced them to forego the use of such machinery and to consent to an arrangement which has proved highly advantageous to the commercial interests of New Orleans, and yet it encounters at the hands of the health authorities of Louisiana constant opposition and detraction. It is needless to say that it will continue to discharge its duties in aid of the health authorities of other States and municipalities notwithstanding the present opposition of the State board of health of Louisiana.

I will add that, owing to a delay in completing the arrangements at Ship Island, which has been due to causes beyond the control of the National Board, the time for extending aid to the health authorities of New Orleans with regard to the prevention of the introduction of contagious and infectious diseases through that port into the United States from foreign countries has not yet arrived. A recent official report to this Board by a committee consisting of three of its members satisfies the executive committee that the sanitary interests of New Orleans, and the surrounding country, will be best subserved by requiring infected vessels, and all vessels from infected ports, to undergo quarantine inspection and treatment at the proposed station on Ship Island. In this way aid will be offered to the State board of health of Louisiana for the protection of New Orleans and all places in direct communication with it.

I will further add, as suggested by the general tenor of your communication, that while the acts of Congress require the National Board of Health to co-operate with and, so far as it lawfully may, aid State and municipal boards of health, it was obviously for the purpose of ascertaining and deciding when and in what manner such aid should be given that a National Board was created. Had this not been so, and had Congress intended to allow each State and each municipality to decide these questions for itself, it would, doubtless, have dispensed with any intermediate instrumentality, and have authorized each local authority to make its requisition directly on the Treasury Department for funds needed to carry out its objects.

Respectfully,

J. L. CABELL,
President National Board of Health.

Dr. JOSEPH JONES,
President of State Board of Health of Louisiana, New Orleans, La.

D.

THE FEVER ON THE LOWER MISSISSIPPI.

NEW ORLEANS, *October* 4, 1880.

SIR: Definite information of the existence of a suspicious form of fever in Plaquemine Parish, La., on the Lower Mississippi, having been received by the member of the National Board of Health resident in New Orleans, George M. Sternberg, surgeon, U. S. A., was requested to visit the locality, examine such number of cases as might be necessary to enable him to determine the nature of the fever, and report the result of his investigation to the New Orleans member. Surgeon Sternberg was selected for this duty because of his extensive and intimate acquaintance with the fevers of the Gulf coast and Spanish Main; because of the recognized skill and ability which had led to his being chosen one of the experts on the Havana Yellow-Fever Commission, and to his being intrusted with the duty of preparing the article on yellow fever in the supplement to Ziemssen's Cyclopedia, and also because of his position as a United States Army medical officer, which, while it removed him on the one hand from

the probability of having his judgment or conclusions influenced by local or personal considerations, on the other, devolved upon him the responsibility of representing an extremely sensitive professional body.

On the 10th of September Dr. Sternberg made a detailed report, in which, after reciting the history of the sickness from the appearance of the first case, early in August, up to the date of his investigation, he positively asserted the existence of yellow fever of a mild type, with a low rate of mortality, except where the disease was aggravated by vicious local conditions. In the area where this prevailed, Dr. Sternberg also found a malarial fever, attributed by the local physicians to exposure in the rice harvest, and which they called rice fever.

Upon receipt of this report a telegram was sent to the executive committee asking that, if Dr. Sternberg's opinion was of sufficient weight, an appropriation of from five thousand to ten thousand dollars be made from the contingent fund and placed at the disposal of the Louisiana State board of health for use in the necessary preventive measures. The appropriation was immediately ordered, and a tender of the sum was made, as above indicated, on the 13th of September.

Recognizing only the existence of the so-called rice fever, the State board declined the offer of the National Board and claimed to have "instituted such measures as it deemed necessary." Up to this time the action of the Louisiana member representing the National Board of Health had been governed by that portion of sec. 3 of the act of June 2, 1879, which makes it the duty of the board to "co operate with and, so far as it lawfully may, aid State and municipal boards of health in the execution and enforcement of the rules and regulations of such boards to prevent the introduction of contagious or infectious diseases into the United States from foreign countries, and into one State from another."

The rejection of this proffer to "co-operate and aid," however, now made it incumbent upon the National Board, through its representative, to take such steps as might determine whether the contingency was grave enough to warrant action under that clause in section 3 which directs the board to "report the facts to the President of the United States," whose duty it then is to use the Executive authority in executing and enforcing the necessary rules and regulations. With this object the member of the National Board of Health resident in Memphis was summoned to New Orleans, and, after careful consideration of all the facts, it was decided to send a commission of three medical gentlemen to the compromised locality, and to base the action of the board upon the report of said commission. These gentlemen (selected with the approval of the auxiliary sanitary association) were Dr. J. Dickson Bruns, of New Orleans, Dr. J. P. Davidson, of the Louisiana State board of health, and Surgeon Sternberg, U. S. A., and they were accompanied on their mission by the Tennessee member of the National Board, the Louisiana member being prevented by his only partial convalescence from a recent attack of the prevailing dengue.

Without entering upon any discussion of the two reports made, the one by Drs. Bruns and Davidson, and the other by Surgeon Sternberg, it is sufficient for the present purpose to say that it was made evident, as well by the conflicting reports of the commission as by the personal observation of the Tennessee member, that no practical benefit could now be attained from Executive interference.

Whatever danger had threatened the public health of the Mississippi Valley had either passed away—the disease having run its course—or it had been so widely scattered that preventive measures on any adequate scale were impracticable for the time being.

Considering the advanced stage of the season, the favorable health conditions of the valley, the more than doubtful utility of any steps still possible looking to isolation, disinfection, &c., and the desirability of avoiding overt action likely to create anxiety and apprehension, if not positive panic—these considerations have induced the representatives of the board to refrain from recommending further action in the premises at the present time.

They cannot, however, close this report without placing themselves on record as fully accepting and indorsing Surgeon Sternberg's conclusions, to wit:

1. That yellow fever (about 100 cases) existed between August 1 and September 10 in Plaquemine Parish, Louisiana.

2. That the outbreak had its origin in the immediate vicinity of the Mississippi River quarantine station, the first case, August 1, occurring directly opposite the point where the infected bark Excelsior was detained from July 11 to August 16.

3. That while the type of the disease was generally mild, vicious local conditions existed which aggravated it into the most fatal form, four dying in one family out of five attacked.

The details of the investigations upon which these conclusions are based will be found in the accompanying reports of Surgeon Sternberg.

All of which is respectfully submitted.

S. M. BEMISS,
Member National Board of Health, New Orleans, La.
R. W. MITCHELL,
Member National Board of Health, Memphis, Tenn.

To the SECRETARY OF THE NATIONAL BOARD OF HEALTH,
Washington, D. C.

[Copy of letter sent to Joseph Jones, M. D., President Louisiana State Board of Health.]

NEW ORLEANS, LA., *September* 13, 1880.

SIR: I respectfully call your attention to the accompanying report from Dr. G. M. Sternberg, regarding the disease at this time prevailing on the lower coast of the Mississippi River. In my opinion, the symptoms and mode of spread bear so close a resemblance to yellow fever that no time should be lost in applying all possible means to prevent its further spread. With a view to the accomplishment of this end, I have to inform you that you are authorized to draw upon the National Board of Health for such sums of money as may be necessary to procure disinfectants and to pay for the services of sanitary police and sanitary inspectors, and in truth all expenses expedient to the purposes mentioned. This money cannot be drawn from the Treasury except in payment of bills for services or articles, which bills must be duly authenticated. You will therefore make requisitions from time to time for such service, disinfectants, &c., as are in your opinion required, and forward same to me. This appropriation will apply to cases of infectious disease in this city, and in all places within the limits of the State which have no local boards to exercise such powers. The organization of the work will rest with yourself, subject to the approval of the National Board. You will therefore in all cases forward me the names of persons recommended to be employed, with pay of each, and each one must take an oath of office, and have his name carefully entered upon blank pay-rolls which will be furnished you, and then no trouble will occur in regard to payments. It is well to remark that the Treesury Department refuses to pay for goods or clothing destroyed to prevent spread of disease, but will pay any reasonable expenses for cleaning and disinfectants.

S. M. BEMISS.

Dr. JOSEPH JONES,
President Louisiana State Board of Health.

[Copy of report by Dr. George M. Sternberg, U. S. A.]

NEW ORLEANS, *September* 10, 1880.

SIR: I have the honor to report that, in compliance with your request, I have visited Point Michel and Point á la Hache, for the purpose of ascertaining the nature of the sickness prevailing there. Dr. Hays, in whose practice most of the cases have occurred, aided me in every manner possible, and in his company and that of Dr. Taylor, who represents the State board of health, I visited about twenty cases of the prevailing fever. Many of Dr. Hays's patients are convalescent, but in the practice of Dr. Heber, on the opposite side of the river, I found three recent cases in one house and three in another distant five miles from the first. In one of these houses we also found the dead body of Andrew Dragon, a light mulatto, aged 17, who died about two hours before our arrival. Dr. Hays has had in his practice 61 cases, and Dr. Heber, so far as I could learn, 7 cases of the prevailing fever. The first case occurred August 15th, in the practice of Dr. Hays, on the right bank of the river, seven miles below his house.

The following day a case occurred two miles above the first. On the 20th (August) another case occurred in the vicinity of the first, and 1 within two miles of Dr. Hays's house. On the 22d, 2 cases; on the 23d, 2 cases; and on the 24th 2 cases were taken sick in the neighborhood of the first case; on the 24th 3 cases also occurred in a locality one and one quarter miles above the doctor's house. This was followed by 3 on the 25th and 3 on the 26th in the same locality. Dr. Hays was also called to see a case on the opposite side of the river, four miles below his house, on the 23d. In the locality one and one-fourth miles above Dr. Hays's house four children have died in the family of —— Girdeau. The two remaining children in the family had been seriously sick, but at the time of my visit appeared to be convalescent. A young man named Little, aged 19, also died in this vicinity, making 6 deaths in all, on both sides of the river, in a total of 68 cases. It is not my intention at present to study this local epidemic from an etiological point of view. I desire simply to state the facts as I was able to glean, in a single day, which have a bearing upon the question of diagnosis. While abundant rains fell during the month of August above and below this vicinity, I am informed that for a month, until quite recently, there was no rain in this immediate neighborhood; also, that a disagreeable odor was observed to come from *batture* along the river bank. Rice is cultivated extensively in the vicinity, and one or two of the cases were taken sick while at work in the rice-fields. I would observe here, however, that nearly all of the cases are young children, and that the adults who, by reason of their exposure in the rice-fields, would be most subject to malarial poisoning, have to a great extent escaped. The cases have mostly been children of French creoles—light mulattoes—who constitute the greater portion of the population in this vicinity. I inquired as to whether any of the cases had previously suffered from yellow fever, but could not get any very definite information. A similar fever prevailed in 1878, which some physicians called yellow fever, but Dr. Hays believes it also to have been malarial fever. The area in which this fever prevailed, on the right bank of the river, was somewhat different from that in which most of the

cases have occurred this year. The fever of 1878 did not extend below a certain point, while the fever of this year has been mostly below this line. As to the nature of the disease, it is a continued fever of a single paroxysm, lasting, it is said, from a few hours to four or five days. No regular temperature observations have been made, but from the statements of Dr. Hays, and my own observations, I am satisfied that the fever is of a mild grade, and not characterized by remissions or intermissions. The highest temperature observed by me was 103½° (second day of disease). At the outset of the attack the eyes are glistening, pupils more or less dilated, gums bright red and swollen, tongue slightly or heavily coated with a white fur, in some cases almost clean, and in one dry and brownish. The skin is usually moist and perspiring. In two cases I noticed that the excitement caused by our presence caused the perspiration to cease and the skin to become dry. Pulse rather soft and not very frequent (in two cases, second day, in which I counted it was 100). Slight pain in head and loins, at commencement of attack. Afterwards no pain was complained of, except occasionally some epigastric distress. There was bilious vomiting at the outset in some of these cases. In others no vomiting occurred. In only one of the fatal cases (child of Girdeau) was there a suspicion of coffee-ground vomit. One or two had nose-bleed at the commencement of the attack. No other hemorrhages are reported. Dr. Hays had not discovered any albumen in the urine of his fatal cases. In Dr. Heber's fatal case the urine was highly albuminous, and suppression occurred 16 hours before death. The depending portions of the body of this young man presented a mottled appearance two hours after death. His natural color was light yellow. I did not discover any decided yellowness of the conjunctivæ in any case. Yellowness of the skin I could hardly have distinguished, on account of the complexion of the patient. I found albumen in three cases. Other cases in which no albumen was found were too far advanced in convalescence or too early in the disease to make the absence of albumen a point of diagnostic importance. In one case, in which the most abundant deposit of albumen occurred—a boy of 12—the boy was dressed and sitting up. He had slight fever, glistening eyes, red spongy gums, and slight headache. Finally, as to the diagnosis, I believe these cases to correspond with what is known in the Antilles and tropical America as *fièvre inflammatoire, fièvre d'acclimation, fièvre jaune bénigne, fièvre jaune abortive, fièvre jaune des Creoles, dengue*, etc. Bérenger-Feraud says of these fevers, "These fevers may exist sporadically, like the yellow fever, and also epidemically, *but it is above all at the approach or decline of the epidemics of yellow fever that they are observed in the greatest number*. They present different forms; the most frequent form is observed among peoples *who are subject to be attacked by yellow fever*. It offers all the symptomatic appearances of the first degree of yellow fever, coloration of the skin and eyes, elevation of temperature and pulse, cephalalgia, rachialgia, contusive pains in the limbs. But whatever may be the intensity of these symptoms they all disappear at the end of 24 or 48 hours, and recovery takes place." In 1875 Bérenger-Feraud lost but three cases in 400, and in 1876 one case in 210. Such is the resemblance of this form of fever with the first degree of yellow fever that when it is observed sporadically without an epidemic of yellow fever the doctors of the country say, "If we were in the time of yellow fever we would say that it is yellow fever." Bérenger-Feraud claims that this fever prevails everywhere that yellow fever reigns, and says "It is a disease very near if not identical with yellow fever—an incomplete yellow fever." For me this fever is identical with yellow fever, and only differs in degree from the more severe forms which, because of the fatality which attends them, are known and dreaded by all. It seems to me extremely unscientific to make our diagnosis depend upon a greater or less percentage of mortality, and the sooner physicians in the yellow-fever zone admit, what I believe to be true, that yellow fever is not always a malignant disease, and that the immunity of creoles is due to their having suffered (generally in childhood) from this milder form of the disease which has received so many different names, and that it is not a birthright, the better will it be for the progress of medical science and the true interests of the countries where these diseases prevail.

GEO. M. STERNBERG,
Surgeon U. S. A.

SECOND REPORT OF DR. GEORGE M. STERNBERG, U. S. A., MEMBER COMMISSION VISITING POINT À LA HACHE AND VICINITY.

I regret to say that I can find no good reason for changing the opinion, given after my first visit to Point Michel, as to the nature of the fever prevailing in that vicinity. I have not seen during either visit any case which, *alone*, would enable me to make a positive diagnosis of yellow fever, but from a consideration of all the cases seen by me during my two visits, and of the facts relating to the origin and progress of the epidemic, cannot doubt that this fever is the mild type of yellow fever which has been described under various synonyms given in my previous report, and which Blair more properly calls "yellow fever *simplex*" to distinguish it from the more malignant type called by him "*gravior*." The main facts upon which I base this opinion are the following: The first cases, so far as I can learn, occurred in the practice of Dr. Westerfield directly opposite the quarantine station, about the 1st of August. It will be remembered that the infected bark Excelsior was anchored at this point for eleven days from June 24 to July 5. No cases occurred in Dr. Westerfield's practice for four or five days after the first case, when six cases occurred in one family, 1½ miles below, then seven cases in another family about the middle of August. It was about this time (August 15) that Dr. Hays saw his first case, 7 miles down the river from his house. This locality subsequently furnished a considerable number of cases (at least 15). Later (August 24), an infected locality was developed 1½ miles above Dr. Hays's house; up to this time no deaths had occurred, but in this locality four children died in one family, and a young man in the immediate neighborhood still later. September 4, the fatal case of Adrian Dragon and other mild cases in the same family occurred in the practice of Dr. Hébert, on east bank of the river, and several miles farther up stream. In the practice of Dr. Wilkinson, on the west bank of the river, and just above Dr. Hays's, no cases of the same fever have occurred. Dr. Westerfield says that his cases occurred mostly where there is a batture on the river front; where there was no batture he had no cases. He says the disease has taken the same course as in 1878. He does not recollect that one of the cases of this year had fever in 1878. The majority were French children. Has had some severe cases with great irritability of stomach, but no deaths. Did not examine the urine or make temperature observations. The theory that this fever results from malarial emanations from rice fields seems to me untenable from the history of this epidemic, as above given, from the fact that adults are most exposed to these emanations, while children are most subject to this fever, and that in various localities where rice is cultivated, as in Dr. Wilkinson's practice, this fever has not prevailed. I am informed that a similar fever does prevail at Port Eads where there are no rice fields. There is, however, in this vicinity a pilot's village and a custom-house station, so that it is presumable that communication with infected vessels occurs before these vessels are subjected to disinfection, &c. I am also informed that communication between this point and the city of New Orleans is unrestricted. At the quarantine station I find a little settlement of two or three houses within a few hundred yards of the wharf, over which the quarantine physician has no control. The facilities for intercourse with infected vessels are certainly not insurmountable, and I find, moreover, that river packets which touch all along the banks of the river on their way up and down from New Orleans are in the habit of tying up for the night at the quarantine wharf. There is, therefore, no difficulty in accounting for the introduction and dissemination of a disease such as I suppose this to be, and from my point of view the battures along the river bank furnish favorable local conditions for the increase of the specific poison of the disease during the summer months. As to the clinical history, I have no reason to believe that all the cases of fever on the river banks have been of the same nature. Drs. Wilkinson, Hébert, and Hays all state that cases of intermittent fever constantly occur in their practice, and doubtless autumnal remittents prevail to some extent. Temperature observations have only been made in a few cases, but the history given me by Dr. Hays and Dr. Hébert of the cases which I have seen, is of a continued fever of a single paroxysm, lasting from twenty-four hours to four or five days. I have obtained an incomplete record of temperature in two cases only. Tommy Gilmore, aged 10, was taken sick at *midnight* Sunday (September 12); no chill; temperature 106°; Monday morning temperature 105°, evening 104°.5; Tuesday morning, 104°; Wednesday 3 p. m., 103°; Thursday morning, 101°.6. I was unable to obtain a specimen of urine for examination in this case. Michael Halcum, aged 25 (?), says he had yellow fever in 1867, taken sick at 10 a. m. Sunday (September 12); temperature Sunday noon, 103°; Monday morning, 101°.8+, evening 102°.2+; Wednesday morning, 101°. Has albuminous urine, highly acid, and containing granular tube casts. In one case, in the practice of Dr. Jones, a relapse occurred from exposure before complete convalescence was established. We found this patient, a boy of 12, very much prostrated, and having highly albuminous urine of acid reaction, containing granular tube casts. This is the fifth case in which I have found albumen in the urine, and that in a fever which is chiefly characterized by the mildness of its course and the absence of distressing symptoms—a very different fever, in my view, from the high grade of malarial fever, with a tendency to local congestion and hemorrhages, which occasionally presents the phenomenon of albuminous urine. In one case, in the stages of calm the patient had a pulse of 60 beats in the minute. I should say, from my observations, that this fever is characterized by rather a slow (after the first day) and soft pulse, a perspiring skin, a clear intellect, and an irritable stomach. I did not observe yellowness of the skin or conjunctivæ in any case; but do not look upon this symptom as a common characteristic of the milder form of yellow fever. My experience in regard to this point corresponds with that of Blair, who says: "It certainly must be admitted that a large proportion of the cases of yellow fever are unattended by yellowness of the surface or even of the eye, for the disease may be cut short by treatment (?), or the epidemic may be of the simplex grade, or the mitior and the yellow suffusion may be so slight as to escape notice." The total number of cases has been about 100, exclusive of those occurring in the practice of Dr. Westerfield, whose figures I did not obtain.

The temperature chart in the case of Dr. Wilkinson, jr., as given by Dr. Finney, certainly justifies a diagnosis of remittent fever; but, as already stated, the history given by Dr. Hays and Dr. Hébert, both

101⅗° Fahrenheit. *Facies* cheerful, skin pleasant. From the excessive nervousness of the little patient, we could not secure a specimen of urine for examination at either visit.

In this locality we also visited, with Dr. Hays, Millandon Potoon, black, male, aged fourteen years, who was said to have had a relapse, succeeding a fever of four days' duration. We saw him again the following morning. At neither visit did he have any fever. The skin was rather cool, temperature normal, pulse soft and very compressible, but not frequent. The appetite was feeble, strength much exhausted, mind spiritless and dejected. He answered questions willingly but slowly, and without animation. The decubitus was lateral, with the legs semiflexed, and we found him lying in exactly the same position, with the same air of utter indifference, on our second visit as we had left him on our first. He made no complaint, and on repeated inquiry admitted no special discomfort. His mother told us that he had been at work in the fields up to the date of his first attack; but the very great emaciation he exhibited was certainly not attributable to the brief acute attack he had experienced. He looked to me to be like a well-advanced case of tuberculosis, and on inquiry I learned from Dr. Hays that his father had died of phthisis pulmonalis. Dr. Hays had never examined his chest, and his condition and surroundings were such as not to invite my personal auscultation of him. A specimen of his urine exhibited, on the usual tests, an abundance of albumen.

In the same room lay a younger brother of Millaudon, convalescent from a mild attack of the fever.

At the quarantine station, which we reached at 9 p. m., we found to our regret the assistant quarantine physician, Dr. C. P. Wilkinson, down with the fever. He had been taken with the usual symptoms of chill, headache, pain in the back and legs, at 6 a. m. on Sunday, the twelfth, and when visited by us on Wednesday at 10 p. m. was, therefore, within 8 hours of completing his fourth day. The quarantine physician, Dr. Finney, had kept an accurate record of his temperature—the sole instance in which we had the fortune to obtain it—from which it appeared that, on seizure, his temperature was 100⅘° Fahrenheit. At noon the same day it was 103, and the same in the evening.

	Temp. Fahr., °.
Monday morning	101
Monday afternoon	104
Tuesday morning	101
Tuesday afternoon	104
Wednesday morning	101
Wednesday afternoon	104
And at 10 p. m., as taken by myself	103

He had, when we saw him, a hot skin; broad, moist tongue, covered with white fur; pulse 90, full, soft, regular; no precordial nor abdominal distress nor vomiting throughout the attack. He had taken quinine in ten-grain doses three times on day of attack, but owing to the irritation it excited, had at first moderated and then discontinued its use. Wednesday he had taken two three-grain doses. He talked to us with unusual animation and energy that night, and the following morning when we visited him, a little after daybreak, we found him perfectly free from fever, in high spirits, and only anxious to resume as soon as possible the duties which he has performed with so much zeal, fidelity, and intelligence.

Dr. Wilkinson is a native of Louisiana, aged 30 years. He stated that he had had an attack of yellow fever, in common with other members of his family, in 1855.

At an early hour the following morning, September 16, we crossed the river to Buras's post-office, which lies immediately opposite the quarantine station. There we had the pleasure of meeting with Dr. Westerfield, whose practice extends for many miles above and below that point. The sum of the information gathered from him was to the effect that the fever had prevailed very extensively in that neighborhood—principally above—which he attributed to the batture, there being a caving bank, washed by the river below. The fever had made its first appearance early in August, and about ten days thereafter had spread through the entire settlement, as many as five, six, and seven cases occurring in single families, and in some of these death by yellow fever had happened in 1878. The majority of his cases had been among white children. Negroes enjoyed, seemingly, more immunity, and females still greater. The average duration of the fever was about 48 hours, he thought. It yielded readily to quinine; fevers chiefly of the remittent type, though he had seen a few intermittents. There had been no death in his practice, nor had he seen a single case in which there was jaundice, black vomit, or suppression of urine.

Dr. Jones, whose area of observation and practice lies on the same bank of the river, between that of Dr. Westerfield and that of Dr. Hays, and with whom we passed some time later in the day, had treated about thirteen cases in all. There was, he thought, a well-marked remission in every case he had seen, but he had made no thermometric observations. The exacerbation took place toward night. The fever yielded readily to quinine, which he gave freely. The only difficulties he had experienced in the management of his cases arose from the tendency to undue cerebral excitement in children. He had lost none, nor had he seen any case with jaundice, black vomit, or suppression of urine.

Dr. Ryan told Dr. Davidson that at Pilot Town the same fever had prevailed extensively. He regarded it as a malarial fever, remittent in type. It yielded readily to quinine. He had no death in his practice, nor had any of his cases been attended with yellowness of skin or eyes, or black vomit, or suppression of urine.

Visiting, with Drs. Hays, Hébert, and Jones, who joined us, such cases of special interest as we had seen on the previous day, we reached Myrtle Grove about 2 p. m., and after an interesting conversation with Dr. J. B. Wilkinson—who, with two of his sons, paid us a visit on the tug—steamed directly for the city, which we reached at 6 p. m. on Thursday evening.

Through your own forethought and Dr. Mitchell's attentions we enjoyed every comfort possible on such a trip, and I take this opportunity, on the part of the whole commission, to express their deep sense of the courtesy they received from all the medical practitioners of the coast, who, with equal candor and cordiality at much self-sacrifice, devoted a large part of the two days to showing us every case of interest in their practice and giving us all the information that could possibly throw any light on the object of our mission.

From personal observation, and from the information gathered on the spot, I have no hesitation in expressing, with the utmost confidence, the conviction that the disease now and lately prevailing on the lower coast is an endemic malarial fever of remittent type, and for the most part of a mild character. Its unusual prevalence is due partly to the meteorological conditions of the past summer, and partly, I believe, to the widely increased cultivation of rice. The alarm it temporarily excited was owing to its fatal results in a single family at the outset. Beyond this isolated instance it has been attended with the slightest mortality, and but for that it would have scarcely excited comment except as to its prevalence and diffusion. The diagnosis obviously lies between malarial and yellow fever, and the reasons for assigning it to the former class seem to me patent and indisputable.

In the first place, all the practitioners in the infected district agree in the opinion, unqualifiedly expressed, that the disease is remittent fever, such as they are accustomed to treat every summer. The laity seem generally to share their views, giving the fever the trivial names, indifferently, of *la fievre du pays* or *la fievre paludienne*. Its ready amenability to quinine is, in itself, a strong proof of its miasmatic nature. If accurate records had been kept they would have been of prime assistance in arriving at certain conclusions; but, owing to loss or breakage of instruments, Dr. Hays was the only physician we met possessed of a thermometer, and the infrequency of his visits, from the great number of patients and the distances to be traveled, lessened the value of his observations as a clinical aid to diagnosis. Nor was it possible, from the most painstaking inquiry, to extract any supplemental information from the attendants or families of the sick. For the most part untrained, ignorant, careless, incapable, alike of observing or describing the most familiar phenomena, the utmost that could be hoped from them as nurses would be to give a dose of medicine at prescribed hours. Under these circumstances the general impression of the medical attendant as to the continued or interrupted course of the fever is the only evidence that can be had, and this, as I have stated, was uniformly to the effect that in all the cases diurnal remissions occurred, usually in the morning, judging from lowered pulses, diminished heat of skin, moisture, &c.

In theory and in text-books a remission is a well-defined, notable abatement, at calculable intervals, of all the more prominent symptoms of the fever, lasting for many hours. But at the bedside, especially in our graver forms of autumnal fevers, a remission is too frequently an obscure, imperfect, and ill-defined pause, as it were, between two prolonged exacerbations, filling up almost twice the entire round of twenty-four hours. The temporarily lowered pulse swiftly resumes its force and frequency; the moisture, slight and transient, extending only over the forehead, face and neck, quickly dries up, and the accurate and continued observation which marks the brief return of the same phenomena at the same hour of the succeeding day can alone truly interpret its quality and meaning.

With their imperfect opportunities and means of detecting such remissions it is scarcely to be wondered at that the physicians had no charts to exhibit. But Dr. Wilkinson was suffering when we saw him from the same type of fever that we had seen in him all day, and in his case the record kept by Dr. Finney supplies the missing link. It shows an access of fever, lasting all Sunday, with a well-marked remission in the morning and exacerbation in the evening of the following day, and the exact repetition of this rise and fall of temperature on two successive days thereafter, terminating at the end of the fourth day in a complete apyrexia.

Had a similar record been kept in all the cases, I do not doubt that it would have equally exhibited their remitting character, though doubtless in many of them the remissions may not have been so strongly marked.

So much concerning the type. Of the nature of the fever, without multiplying details, I will simply say that neither in its special features nor in their entirety could I realize a single prominent characteristic of yellow fever.

The broad, white, lightly furred tongue, moist in all stages, lacking the dry, brown center or fiery tip and edges; the firm gums, free from sordes or oozing, or the clear or only lightly suffused eye, not

smoky or brilliant or dull, with no tinge of yellowness; the warm, pleasant skin, neither bathed in hot sweat, nor harsh, nor pungent to the touch, nor bronzed nor jaundiced nor exhibiting capilliary congestion; the universal freedom from jactitation and delirium; the normal respiration, neither hurried, nor labored, nor sighing; the *facies*, free alike from terror or depression, calm, cheerful, smiling; the notable absence of any stage of calm intervening between a primary or secondary fever or of black vomit, or tarry dejections, or suppression of the urine, or sudden cardiac syncope, render it as certain as clinical observation can that the fever is not yellow fever.

And if we except the Giordano family, the extremely light mortality is no new important factor in the conclusion. Dr. Hays attributes the death of these four children of one household to their intractableness and refusal to take medicine. Now, in the graver forms of malarial fever the early and free administration of quinine often offers the sole means of saving life; but I cannot help thinking that, in this instance, there coexisted some peculiarly malign local influence not made out, or special family predisposition not understood—a fact we are called on frequently to deplore. For of at least 150 cases that we can reckon, and doubtless a large number of others among the negroes, who neither sought nor obtained medical assistance, scattered along both banks of the river, under bad hygienic conditions, crowded in close, damp, dark, ill-ventilated rooms, seen usually late and necessarily infrequently, with no nursing, or worse, lifted out of bed or seated up for every occasion, in every stage of the disease, and fed or starved as fortune favored—improperly and unseasonably often, and as the waking or the whim of the nurse chanced; out of this large number of cases, as we have said, but two deaths have occurred. Yellow fever, whenever it prevails—so far as I know—stands high among the most fatal diseases of our nosological table.

Nor is there any hint of such a march of the disease from house to house, or by personal contact, as can almost always be traced in contagious diseases breaking out among a sparse population, and never so easily traced as under such conditions as exist here, when the dwelling-houses are stretched along in one continuous and unbroken line, following the curves of the levee under which they lie.

What are the facts? Dr. Westerfield told us that his first cases occurred early in August, and by the tenth, after a pause of a few days, the whole settlement was involved. Dr. Hays gives a somewhat similar history of his section; but his first case did not occur until the 15th of August. Now the middle of Dr. Westerfield's line is directly opposite the quarantine station. Dr. Hays's practice lies many miles above. And at first sight this might seem to furnish a clue to the source of the disease, if it were yellow fever, although we know of but one infected ship, the Excelsior, at quarantine this summer, though of course many ships from infected ports have been detained there from time to time. The solution of the phenomenon, granting the disease to be malarial, is not far to seek. Owing to the shorter distance to the Gulf, and the natural configuration of the land, drainage in the lower is much more rapid than that in the upper part of this area. Mr. F. C. Brooks, a planter of the neighborhood, informs me that, although the rice matures in both sections about the same time, the difference in the time of drainage (the water being let off the fields simultaneously) is from seven to ten days, nearly. As the water is let off usually about the middle of July, the fever, as might have been anticipated, made its appearance along the river from below upwards just so soon as the hot sun of July and August could draw up from the reeking ground the miasm which, whatever its specific nature, is doubtless telluric in its origin.

Finally, the epidemic now prevailing in the parish of Plaquemine is, unhappily, not confined to the lower coast. Along both banks of the river as far up as Donaldsonville, in Jefferson, in Saint John Baptist, Saint Charles, Saint James, and Ascension, I am informed by my friends—physicians and planters—that the same or a similar fever exists. Since the latter part of June I have treated in New Orleans a fever identical with that which I found in Plaquemine, invariably remittent, and many of them far more serious than any which I saw below. A few days only before I started on this mission I had treated for a severe remittent the clerk of the *Alvin*, a packet in the lower coast trade. He was seized with the fever on the coast and brought to the city with it.

And this wide-spread outbreak of malaria, during the present summer, is generally attributed by the residents along the river, above and below, to the increased acreage under cultivation in rice. In a letter from Dr. E. Duffel, of Ascension, dated September 13, and received on my return, that most competent observer says: "I am very busy, having a great many cases of malarial fevers, at times very fatal, particularly if neglected at first. One of the worst complications is congestion of the brain, and few, if any, recover when thus affected. The extensive cultivation of rice in Louisiana will be very detrimental to the health of the people and a scourge."

A planter on the lower coast tells me that eight or nine years ago malarial fevers were comparatively infrequent and mild in that section, but have increased in numbers and severity just in proportion to the increase of the rice area. I do not doubt the truth of the statement, which is in strict accordance with all we know of the history of rice culture and its connection with miasmatic fevers elsewhere, notably in South Carolina and Georgia. In Louisiana two potent causes will contribute to the increased cultivation of this cereal. The poor man will give a natural preference to a crop which can be raised with small expenditure of labor, and which needs no capital to take it off, and the wealthier sugar planter finds in it a valuable accessory to his main crop, harvested early, commanding cash readily, and furnishing, at the very season he most needs it, the large outlay required to convert his standing cane into a marketable commodity.

Whether the health of New Orleans will thus be endangered only time can show; but that our hitherto salubrious lowlands, if turned into paddy fields, will become hotbeds of malaria, hostile to the health and perhaps fatal to the presence of the white race, there is little reason to doubt.

I have the honor to be, very respectfully, your obedient servant,

J. DICKSON BRUNS, M. D.,
Chairman Committee on Fever of Lower Coast.

I concur with the above full and able report regarding the disease prevailing on the Lower Mississippi coast as essentially a miasmatic fever of a remittent type, occasioned by the emanations from the rice fields stretched along the coast, and its diffusion over so extended an area as probably due to the peculiarities of the present season, characterized, as it has been, by long-continued rains, followed, at harvest time of the rice, by very hot and dry weather. I saw no case of the fever which, in my judgment, could be said to present the diagnostic signs of yellow fever.

J. P. DAVIDSON, M. D.

S. M. BEMISS, M. D.,
Resident Member National Board of Health.

[Copy of telegram from Dr. F. Loeber, acting president of the Louisiana State board of health.]

NEW ORLEANS, LA., *October* 5, 1880.

DR. T. J. TURNER,
Secretary National Board of Health, Washington, D. C.:

One death from yellow fever on the night of September 4, at No. 409 South Liberty street, nearly a mile from the commercial centers, and the same distance from the harbor. Immediate burial, disinfection of prémises have been enforced, and all precautions will be taken.

F. LOEBER,
Acting President State Board of Health.

SUPPLEMENT No. 9,
National Board of Health Bulletin.

REPORT OF COMMITTEE ON THE NOMENCLATURE OF DISEASES AND ON VITAL STATISTICS.

WASHINGTON, D. C., *October* 20, 1880.

SIR: The committee upon the Nomenclature of Disease, &c., appointed at the conference called by the National Board of Health, in Washington, May 6, 1880, respectfully submit the following report and recommendations:

As regards the nomenclature, we have, in accordance with our instructions, carefully considered the matter, and have communicated the results of our deliberations to the committee of the Royal College of Physicians, which is now engaged in the revision of this nomenclature.

We append herewith [marked A] a copy of the communication which we have addressed to this committee, and the matter will probably be presented in more detail by a member of our committee, Dr. Folsom, who will visit England within a short time.

As several States and a number of cities in this country are just beginning to publish reports of their mortality statistics, we deem it expedient to present at once a preliminary report as to the best methods of tabulating such statistics, and upon this we would remark as follows:

I. The question as to the best forms of tables for the *publication* of such statistics is quite different from the question as to the best forms to use in their *compilation*. Very much compilation work must often be done to obtain results which can be published more briefly and economically in a very different form, or which may not seem worth publication at all after they have been obtained.

II. The three great objects to be attained by the publication of mortality statistics are, 1, as a warning of the existence of an excessive amount of disease, especially of the preventable forms, with reference to immediate action; 2, to educate the people as to the importance and interest of such matters, by getting them to compare their own situation as to healthfulness with that of other communities, and to see themselves as they are; 3, as material for the studies of the scientific statistician and the seeker into the causes of disease.

The first object can be best attained by weekly reports for towns and cities, which reports should be brief summaries of the data of the previous week. A postal-card form for such a weekly statement is appended, which is essentially the same as that used by the National Board of Health. [Appendix B.] It is advised, to secure uniformity in time, that the week be held to end on Saturday at noon, and to include all deaths reported up to that time, without reference to the date of death.

This postal report should be sent to the National Board of Health for publication, and the information contained in it should also be given to the local press, with such additions and comments as the health officer can conveniently furnish. Under some circumstances, as during the prevalence of an epidemic, such reports would be required daily.

The second object above referred to is to be promoted by the publication, side by side, of many such weekly reports as have just been mentioned, and by similar comparisons in annual reports. It is unnecessary to refer to the forms needed for this purpose, as they will be discussed under the next head.

The third object is the one that presents the real difficulties. We will first take the case of a city, or single registration district, where the mortality tables are to be compiled directly from the original records.

III. The data to be compiled are (or ought to be) date of death, age, sex, color, birth-place of parents, nativity, occupation, social relation, locality of death (street, ward, &c.), and cause of death.

The items "color" and "birth-place of parents" are relied on to show the race or nationality of the decedent. The item "nativity" refers to the birth-place of the decedent, and is useful rather for genealogical and judicial purposes than for vital statistics. (With regard to the item "race," it is not to be taken as equivalent to "birth-place" or "nativity." The birth-place of the parents, which should be shown on the certificate, will be usually taken to give the "race.") The results of the compilation of these data are to be compared to the living population, the birth-rate, the occupied area, the meteorological and other special conditions of the environment, and with the results obtained in the same locality in previous years.

For statistical purposes, the month should be made the unit of time, although the tabulations we are now discussing will be published but once a year. For educational purposes, and as a matter of local interest, it will be well to publish monthly summaries, which, however, would differ little in form from the weekly reports already referred to.

IV. The first table which a city should give in its annual mortality report, and which should be compiled in the same form, should be one showing the number of deaths from each cause by age and sex.

In all cities where the number of persons of different races or nationalities is large enough to make it worth while, this table should show also for each sex and age the races, as, American whites; American blacks; English and Scotch; French, German, &c. We think this should be done for any race or nationality which forms 5 per cent. or more of the total population.

A form for such a table is appended, marked Table I. So long as each cause of death appears separately, the precise nosological arrangement or order of sequence is a matter of minor importance, but we advise following the order of the nomenclature of the Royal College of Physicians that the order may be the same in all the tables. The information contained in this table is essential to the vital statistician. It cannot be abbreviated without losing much of its value; it will not do to give deaths by ages separate from those by sex. The division of ages, indicated in this table, is the least which will permit of making comparison with the statistical reports of other countries. It is desirable, however, that the deaths under one year be still further subdivided, and that special studies be made of the deaths by days in the first month, and by months in the first year. The importance of distinguishing the race or nationality is very great in the United States at the present time. No other country presents such an opportunity for the study of the effects of race or nationality in disease and mortality; nor will it be possible in this country to study it many years, and hence the great importance of making use of the fleeting opportunity.

In those places where the birth-place of parents is not reported, the only means of deciding the race or nationality, besides the color distinction, is the item of nativity, which should in such case be used, although it is of little value as regards young children.

If a city publishes this table or set of tables, and nothing else, it will be of the greatest value for statistical and sanitary purposes.

V. The second table to be *compiled* should show the number of deaths from each cause, and the number of deaths at certain ages, by months, with distinction of sex. In most cases, however, it will not be worth while to publish this compilation in full, since in regard to many causes of death season has little influence, and the probabilities of any useful increase to knowledge from comparison of mortality statistics with monthly means of temperature, humidity, barometric pressure, and other meteorological data, is, as regards most diseases, very slight.

A form for a table of this kind, such as we would recommend for publication, is appended, marked Table II.

The compilation form for table No. I may be combined with the form for table No. II in one large compilation-sheet, by placing the list of causes of disease in a column between columns for months and those for age.

VI. The third table which we advise, should show the relations of causes of death to social relations, *i. e.*, to marriage and to occupations. A form for this purpose is appended, marked Table III.

With this we close our recommendations of forms for municipal mortality statistics. The forms recommended are not intended to exclude other methods of tabulation. They give the minimum amount of mortality statistics which a city should publish. If it gives these together with its population, the health of its people can be compared with that of other localities, which is the great object of the statistician, and the reason why uniformity in the forms of tabulation is so very desirable. To enable the statistician to compare the health of the same city at different periods, it will often be necessary to continue compilations according to forms already in use, but this should not prevent the use of the forms which are here recommended, and which are intended to secure the means of comparison with other places. We have said nothing about tabulation by wards or districts, as we shall have to consider tabulation by localities when speaking of forms for States, &c., and we have not alluded to, or provided for, the presentation of the results in terms involving ratios, either to living population, to birth-rate, or to total death-rate, because we are stating the essential and minimum amount of work to be done by the local statistician, but we think it highly desirable that such computations of percentages and ratios should be made and published in the local reports as a means of educating not only the people, but the compiler.

The forms of tables for compiling and publishing the mortality statistics for States are governed by the same principles as those for cities, but another factor enters into them to a much greater extent, viz, locality. The unit of area for this purpose in a State should be at least the county or its equivalent (as the parish in Louisiana), and in many cases smaller subdivisions into towns, townships, &c.,

will be desirable. Whatever unit may be taken, the first thing to be done is to obtain for each of them those compilation tables specified as a minimum for the cities; that is, tables 1, 2, &c. Having done this, the next step is to calculate for each locality or unit of area the ratio of the deaths to the estimated living population, and the total number of deaths for the following classes, viz: for deaths under one year of age, deaths under five years of age, and deaths from about twenty of the principal causes or groups of causes.

A comparison of these results will indicate the localities in which further study and special compilation will be desirable. The tabulation of the mortality statistics for the whole State should be, first, the same table as No. 1 for a city; second, the same as No. 2 for a city; third, the same as No. 3 for a city; fourth, a table showing comparison of number of births and deaths.

With regard to classification by localities in a State, there should be a table giving the total number of deaths for each locality by age, sex, and month, and a table giving the number of deaths from each of the twenty principal causes or groups of causes of deaths for each locality. It will be understood that what we are here advising for a State is the minimum amount of statistical information which it should furnish with regard to its mortality, and the same remarks apply to this as to reports for a city above referred to.

The "report on a uniform plan for registration reports of births, marriages, and deaths," presented to the American Medical Association, in 1859, by a committee, of which Dr. Sutton of Kentucky was chairman, should also be consulted by registrars of vital statistics. The forms of tables for reporting deaths, given in that report, are mainly taken from the Massachusetts reports of 1854, and do not seem as desirable as those recommended in this report.

We advise all those engaged in tabulating mortality reports for a city, to study the forms of tables used in the city of Providence and in the District of Columbia. And in like manner those upon whom rest the responsibility for tabulating the mortality statistics of a State should especially study the forms of tables used in the last registration report of Massachusetts, the last registration report of Michigan, and the last annual report of the registrar-general of England, in which will be found additional forms and many suggestions of value.

As a matter of convenience, we have had prepared and append herewith outlines of the principal forms contained in these reports.

All of which is respectfully submitted.

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Surgeon, U. S. Army.
THOMAS J. TURNER, M. D.,
Medical Director, U. S. Navy.
P. H. BAILHACHE, M. D.,
Surgeon, U. S. Marine Hospital Service.
CHARLES F. FOLSOM, M. D.,
Secretary State Board of Health of Massachusetts.
EDWIN M. SNOW, M. D.,
Superintendent of Health and City Registrar, Providence, R. I.

Dr. JAMES L. CABELL,
President National Board of Health.

APPENDIX A.

NATIONAL BOARD OF HEALTH,
Washington, D. C., October 18, 1880.

SIR: I have the honor to transmit herewith a communication from the committee on nomenclature, appointed by the National Board of Health, United States, submitting suggestions with regard to the revision of the nomenclature of the college, and respectfully request that it may laid before the committee of the college charged with revision.

Dr. Charles F. Folsom, a member of this committee, will probably be in London in November next, and it is hoped that he will have an opportunity of meeting the committee of the college and of making further explanation.

Very respectfully, your obedient servant,

J. S. BILLINGS,
Surgeon U. S. Army, Chairman.

HENRY A. PITMAN,
Registrar of the Royal College of Physicians, London, England.

WASHINGTON, D. C., *October* 20, 1880.

The committee appointed at the conference of registrars of vital statistics, called by the National Board of Health in Washington May 6, 1880, to suggest the principal additions to and changes in the nomenclature of the Royal College of Physicians of London which seem most desirable at the present time, and to confer with the committee of the college in charge of revision of said nomenclature with reference to the obtaining of a uniform system for Great Britain and this country, respectfully submit the following suggestions:

I. The synonyms of the new nomenclature should be made as complete as possible, so that any name of a disease which might be used by a physician educated anywhere in Europe may be found in the index. This is especially desirable in this country, where we have physicians from all parts of Europe. The appended list of names of diseases, which are not found in the index to the nomenclature of the college, is submitted in this connection.

II. Malaria, as producing intermittent and remittent fevers and other similar affections, is an important subject of nomenclature and nosological classification in a large part of this country, and it is desirable that this group should be brought together and made distinct.

III. It is advised that the committee consider in the new nomenclature whether a step might not be taken towards establishing a distinction between what may be termed clinical and pathologico-anatomical nomenclature, the first being names of symptoms or groups of symptoms, the second of results of disease. Such a step might be the direction that certain terms, such as posterior spinal sclerosis, cancer of the pancreas, &c., shall be used only to express the result of a post-mortem examination; while certain other terms are to be used only in the absence of such an examination, as is directed in the present nomenclature of the college with regard to encephalitis.

IV. It is considered that the groups of "General Diseases A" and "General Diseases B" are too large for any practical purpose. One of the chief uses of a classification of diseases in such a nomenclature is to enable registrars of vital statistics to summarize certain facts with regard to causes of death. But the classification which is of value to the student of sanitary science is that which is, as far as possible, based on etiology.

From the point of view of the sanitarian, to group small-pox, remittent fever, and typhoid fever together, simply renders valueless the statistics; and the same may be said of the placing together rheumatism, syphilis, cancer, and phthisis.

It is believed that both group A and group B can be so subdivided as to be much more convenient for registration and summarizing than they now are, and for this purpose the following scheme is submitted (A):

The only points in which this scheme varies essentially from the plan of the present nomenclature is in the introduction of the group of "diarrhœal diseases," and in the placing with syphilis the other venereal diseases. We do not attempt to go into details with regard to the rearrangement of the local diseases, which will require in many places additions and transpositions to make them correspond to the present state of medical science and to the nomenclature in use by specialists.

We append, however, as a suggestion, and as a part of this report, papers which have been prepared at the request of the committee by specialists, as follows, viz:

1st. Nomenclature of diseases of the eye and ear, by Dr. Swan M. Burnett, Washington, D. C.

2d. Nomenclature of diseases of the nervous system, by Prof. H. C. Wood, of Philadelphia, Pa.

3d. Nomenclature of diseases of the female urinary and generative organs by Dr. James R. Chadwick, Boston, Mass.

All of which is respectfully submitted.

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Superintendent of Health and City Registrar, Providence, R. I.

Proposed subclassification or grouping of "General Diseases A" and "General Diseases B."

GENERAL DISEASES A.

GROUP 1.—Cholera. Yellow fever. Plague. } Deaths from each of these diseases will be reported separately.

GROUP 2.—Small-pox.
Scarlet fever.
Measles.
Rötheln.
Mumps.
Whooping-cough.

GROUP 3.—Diphtheria.

GROUP 4.—Typhus fever.
Typhoid fever.
Cerebro-spinal fever.
Relapsing fever.

GROUP 5.—Malarial fevers.
Malarial cachexia.
Dengue.

GROUP 6.—Diarrhœa, acute.
Diarrhœa, chronic.
Cholera morbus.
Cholera infantum.

Sclerotico-choroiditis.
Synchesis of the vitreous humor.

AFFECTIONS OF THE CONJUNCTIVA.

Apoplexy of the conjunctiva (ecchymosis).
Burns of the conjunctiva.
Chemosis.
Conjunctivitis, catarrhal.
Conjunctivitis, croupous.
Conjunctivitis, diphtheritic.
Conjunctivitis, follicular.
Conjunctivitis of the globe.
Conjunctivitis of the lids.
Conjunctivitis of the new-born.
Conjunctivitis, phlyctenular.
Conjunctivitis, purulent.
Conjunctivitis, pustular.
Conjunctivitis, trachomatous. granular —
Emphysema of the conjunctiva.
Encanthis.
Hyperæmia of the conjunctiva.
Lithiasis of the conjunctiva.
Metallic stains.
Parasites in the conjunctiva.
Perikeratitic hypertrophy of the conjunctiva. ? useless —
Pinguecula.
Pterygium.
Trachoma. ? —
Tumors of the conjunctiva.
Ulcer of the conjunctiva.
Wounds of the conjunctiva.
Xerosis of the conjunctiva.

AFFECTIONS OF THE CORNEA.

Abscess of the cornea.
Abrasion of the cornea.
Fistula of the cornea.
Foreign bodies in the cornea.
Hernia of the cornea.
Hydrophthalmus.
Hypopyon.
Keratitis, diffuse.
Keratitis, bullosa.
Keratitis, fascicular.
Keratitis, neuro-paralytic.
Keratitis, ~~pannous~~. barbarous —
Keratitis, parenchymatous (interstitial).
Keratitis, phlyctenular.
Keratitis, punctate (pyramidal). unnecessary —
Keratitis, purulent.
Keratitis, traumatic.
Keratitis, vesicular. (Herpes.)
Kerato-conus.
Kerato-globus.
Kerato-iritis. ? unnecessary —
Kerato-malacia.
Leucoma-adherens.
Leucoma of the cornea.
Macula of the cornea.
Onyx.
Pannus, crassus.
Pannus, tenuis.
Resorption ulcer of the cornea.
Sclerosis of the cornea.
Serpent ulcer of the cornea. serpiginous —
Sloughing of the cornea.
Staphyloma of the cornea.
Tumor of the cornea.
Ulcer of the cornea.
Wounds of the cornea.

GLAUCOMA.

Glaucoma, acute.
Glaucoma, absolute.
Glaucoma, chronic.
Glaucoma, fulminans.
Glaucoma, hemorrhagic.
Glaucoma, imminent.
Glaucoma, inflammatory.
Glaucoma, secondary.
Glaucoma, simple.
Glaucoma, sympathetic.
Glaucomatous degeneration.
Essential phthisis bulbi. ? hardly a glaucomatous affection

AFFECTIONS OF THE IRIS AND CILIARY BODY.

Corectopia.
Cyclitis, plastic.
Cyclitis, purulent.
Cyclitis, serous.
Cyclitis, sympathetic.
Exclusion of the pupil. – Seclusion
Foreign bodies in the iris.
Gumma of the iris.
Hernia of the iris.
Hypophæma.
Irido-choroiditis, plastic.
Irido-choroiditis, purulent.
Irido-choroiditis, spongy (gelatinous).
Irido-choroiditis, serous.
Irido-cyclitis plastic.
Irido-cyclitis purulent.
Irido-cyclitis serous.
Irido-cyclitis sympathetic.
Iritis, arthritic.
Iritis, gonorrheal.
Iritis, plastic.
Iritis, purulent.
Iritis, rheumatic. useless —
Iritis, serous.
Iritis, spongy (gelatinous).
Iritis, sympathetic.
Iritis, syphilitic.
Iritis, traumatic.
Iritis, tuberculous.
Iridiræmia.
Mydriasis.
Myosis.
Occlusion of the pupil.
Reversion of the iris.
Rudimentary iris.
Rupture of the iris.
Synechia anterior.
Synechia posterior.
Tremulous iris.
Tumors of the iris.
Wounds of the iris.
Iridodialysis

AFFECTIONS OF THE LACHRYMAL APPARATUS.

Atresia of the puncta.
Dacryo-adenitis.
Dacryo-cystitis, catarrhal.
Dacryo-cystitis, purulent.
Double punctum.
Dacryo-lithiasis.
Eversion of the puncta.
Exostosis of the nasal duct.
Fistula of the lachrymal sac.
Foreign bodies in the punctum.
Polypus of the lachrymal sac.
Stillicidium lachrymarum (Epiphora). ?
Stricture of the nasal duct.

AFFECTIONS OF THE LENS.

Aphakia.
Cataract, accreta. a
Cataract, anterior polar (pyramidal).
Cataract, axial.
Cataract, black.
Cataract, calcareous.
Cataract, capsular.
Cataract, complete.
Cataract, congenital.
Cataract, cortical.
Cataract, diabetic.
Cataract, fusiform (spindle-shaped).
Cataract, hard.
Cataract, hypermature.
Cataract, incipient.
Cataract, incomplete. useless —
Cataract, lamellar (zonular).
Cataract, membranous.
Cataract, morgagnian.
Cataract, nuclear.
Cataract, posterior polar.
Cataract, punctate.
Cataract, secondary.
Cataract, senile.
Cataract, soft.
Cataract, spurious.
Cataract, traumatic.
Coloboma lentis.
Dislocation of the lens.
Phakitis.
Lenticonus.
Subluxation of the lens.

AFFECTIONS OF THE LIDS.

Ablepharon.
Abscess of the lids.
Acarus folliculorem.
Acne moluscum.
Ankyloblepharon.
Anthrax of the lids.
Blepharitis marginalis.
Blepharo adenitis.
Blepharo spasm.
Blepharo phymfsis.
Chalazion.
Chromhydrosis (Blepharal-melasma).
Coloboma palpebrarum.
Distichiasis.
Ectropion.
Elephantiasis palpebrarum.
Emphysema.
Entropion.
Epicanthus.
Erythema of the lids.
Hæmophthalmus externus.
Hæmatidrosis.
Herpes of the lids.
Hordeolum.
Hyperæmia of the lids.
Hyperidrosis.
Infiltration of the lids.
Lagophthalmus.
Nictitation.
Paralysis of the orbicularis.
Phthiriasis ciliarum.
Ptosis atonic.
Ptosis congenital.
Ptosis paralytic.
Seborrhœa.
Tarsitis.
Trichiasis.
Tumors of the lid.
Verruca of the lids.
Xanthelasma of the lids.

AFFECTIONS OF THE MUSCLES OF THE EYE.

Blepharo spasm.
Enopthalmus, spastic.
Insufficiency of the internal rectus.
Insufficiency of the external rectus.
Laceration of the ocular muscles.
Nystagmus, atonic.
Nystagmus, oscillating.
Nystagmus, rotating.
Nystagmus, tonic.
Ophthalmoplegia externa (paralysis of all the external muscles of the eye).
Ophthalmoplegia interna (paralysis of all the internal muscles of the eye).
Paralysis of the ciliary muscles (cycloplegia).
Paralysis of the external rectus muscle.
Paralysis of the inferior rectus muscle.
Paralysis of the internal rectus muscle.
Paralysis of the inferior oblique muscle.
Paralysis of the levator palpberæ.
Paralysis of the motor oculi communis.
Paralysis of the obicularis.
Paralysis of the superior oblique.
Paralysis of the superior sectus.
Spasm of the ciliary muscle.
Strabismus, bilateral.
Strabismus, concomitant.
Strabismus, convergent.
Strabismus, divergent.
Strabismus, downward.
Strabismus, monolateral.
Strabismus, paralytic.
Strabismus, upward.

AFFECTIONS OF THE ORBIT AND GLOBE.

Abscess of the orbit.
Argyria oculi.
Caries of the orbit.
Cellulitis of the orbit.
Dislocation of the eyeball.
Effusion of blood in the orbit.
Emphysema of the orbit.
Fracture of the orbital bones.
Inflammation of the frontal sinus.
Necrosis of the orbital bones.
Periostitis of the orbit.
Panophthalmitis. barbarous
~~Tenonitis.~~
Tumor of the orbit.

ANOMALIES OF REFRACTION, ACCOMMODATION, AND VISION.

Achromatopsia.
Amaurosis.
Amaurosis, hysterical.
Amaurosis, partial, transient.
Amaurosis, without ophthalmoscopic signs.
Amblyopia, alcoholic.
Amblyopia, congenital.
Amblyopia, central.
Amblyopia, saturnine.
Amblyopia, tobacco.
Amblyopia, toxic.
Amblyopia, anopsia (from non-use).
Amblyopia, hysterical.
Anisometropia.
Asthenopia, accommodative.
Asthenopia, muscular.
Asthenopia, retinal.
Astigmatism, compound (myopic or hypermetropic).
Astigmatism, irregular.
Astigmatism, mixed.
Astigmatism, regular.
Astigmatism, simple (myopic or hypermetropic).
Blue-yellow blindness (*Hering*).
Chromatopsia.
Dyschromatopsia (feeble color-sense).
Flittering scotoma
Green blindness.
Hemeralopia.
Hemianopsia, inferior.
Hemianopsia, left.
Hemianopsia, right.
Hemianopsia, superior.
Hypermetropia, axial.
Hypermetropia, from deficient curvature of the refracting surfaces.
Hypermetropia, acquired.
Hypermetropia, latent.
Macropsia.
Metamorphopsia.
Micropsia.
Muscae volitantes.
Myopia, axial.
Myopia, acquired.
Myopia, from excessive curvature of the refracting surfaces.
Myopia, false.
Nyctalopia.
Photopsia.
Polyopia, monocular.
Red-blindness.
Red-green blindness (*Hering*).
Scotoma.
Snow-blindness.
Violet-blindness.

AFFECTIONS OF THE RETINA AND OPTIC NERVE.

Amaurotic cat's-eye.
Apoplexy of the retina.
Atrophy of the optic nerve.
Atrophy of the optic nerve, progressive.
Chorio-retinitis, diffuse.
Chorio-retinitis, disseminated.
Chorio-retinitis, circumscribed.
Commotio retinæ.
Cystic degeneration of the retina.
Detachment of the retina.
Dropsy of the optic nerve sheath.
Epilepsy of the retina.
Embolism of the central artery of the retina.
Embolism of a branch of the central artery of the retina.
Effusion under the retina.
Excavation of the optic disk.
Foreign bodies in the retina.
Hyperæmia of the retina.
Ischæmia of the retina.
Neuro-retinitis.
Neuro-retinitis, ascending.
Neuro-retinitis, descending.
Neuritis, syphilitic.
Œdema of the retina.
Opaque optic nerve fibers.
Papillitis (choked disk).
Peripapillary degeneration of the retina.
Perineuritis, optic.
Perivasculitis, retinal.
Retinitis, albumenuric.

Retinitis, central.
Retinitis, central recurring.
Retinitis, chronic.
Retinitis, circumpapillary.
Retinitis, circumscribed.
Retinitis, diabetic.
Retinitis, diffuse.
Retinitis, hemorrhagic.
Retinitis, leucæmic.
Retinitis, nyctalopic. } unnecessary
Retinitis, oxaluric.
Retinitis, pigmentary.
Retinitis, proliferating.
Retinitis, pernicious anemic.
Retinitis, sympathetic.
Retrobulbar optic neuritis.
Torpor of the retina.
Tumors of the retina.

AFFECTIONS OF THE SCLEROTIC.

Anterior scleral staphyloma.
Episcleritis.
Foreign bodies in the sclera.
Posterior scleral staphyloma.
Scleritis.
Wounds of the sclera.

AFFECTIONS OF THE EXTERNAL EAR.

Congelation of the auricle.
Eczema of the auricle.
External auditory canal, atresia of.
External auditory canal, circumscribed inflammation of.
External auditory canal, condylomata in.
External auditory canal, diffuse inflammation of.
External auditory canal, exostosis of.
External auditory canal, foreign bodies in.
External auditory canal, hyperostosis of.
External auditory canal, polypus in.
External auditory canal, pruritus of.
External auditory canal, ulceration of.
External auditory canal, vegetable fungous growths in.
Inspissated cerumen.
Inflammation of the auricle.
Malformations of the auricle.
Perichondritis.
Tumors of the auricle.
Wounds of the auricle.

AFFECTIONS OF THE MIDDLE EAR AND MEMBRANA TYMPANI.

Anchylosis of the ossicles.
Caries of the temporal bone.
Exfoliation of the temporal bone.
Fracture of the malleus handle.
Membrana tympani, acute inflammation of.
Membrana tympani, adhesion of, to the promontory.
Membrana tympani, calcareous deposits in.
Membrana tympani, chronic inflammation of.
Membrana tympani, destruction of.
Membrana tympani, ecchymosis of.
Membrana tympani, formation of bone in.
Membrana tympani, injuries to.
Membrana tympani, perforation of.
Membrana tympani, rupture of.
Mastoid cells, catarrhal inflammation of (primary).
Mastoid cells, catarrhal inflammation of (secondary).
Mastoid cells, periostitis of (primary).
Mastoid cells, periostitis of (secondary).
Mastoid cells, suppurative inflammation of (primary).
Mastoid cells, suppurative inflammation of (secondary).
Middle ear, acute catarrhal inflammation of.
Middle ear, acute suppurative inflammation of.
Middle ear, caries and necrosis of the walls of.
Middle ear, chronic catarrhal inflammation of.
Middle ear, chronic suppurative inflammation of.
Middle ear, exostosis of.
Middle ear, hemorrhage into.
Middle ear, hyperostosis of.
Middle ear, polypus in.
Middle ear, proliferous inflammation of.
Middle ear, tumors in.
Necrosis of the temporal bone.
Myringomycosis.
Otalgia.

AFFECTIONS OF THE INNER EAR.

Boiler-maker's deafness.
Deafmutism.
Deafness to certain tones
Double hearing with both ears. Paracusis Willisii
Inflammation of the labyrinth, primary.
Inflammation of the labyrinth, secondary.
Ménières complex of symptoms. — awkward —
Nervous deafness.
Restricted range of audition.
Tinnitus aurium.

OPERATIONS ON THE EYE.

On the conjunctiva.

For pterygium.
Removal of tumors.
Removal of foreign bodies.
Syndectomy (peritomy).

On the cornea and anterior chamber.

Ablation of staphyloma.
For serpent ulcer of the cornea (*Sämisch*).
Paracentesis of the cornea.
Removal of foreign bodies from the cornea.
Removal of tumors from the cornea.
Removal of foreign bodies from the anterior chamber.
Tattooing of the cornea.

On the globe and orbit.

Enucleation of the globe.
Exenteratio orbitæ.
Extraction of foreign bodies from the interior of the eye.
Neurectomy.
Optico-ciliary neurotomy.
Paracentesis of the walls of the globe.
Puncture of the optic-nerve sheath.
Removal of tumors from the orbit.
Removal of tumors from the optic nerve.
Sclerotomy.

On the lids.

For ankyloblepharon.
Blepharoplasty.
For destruction of the hair follicles.
For ectropion.
For entropion.
For enlargement of the palpebral opening.
For evacuation of cysts.
For excision of piece of tarsal cartilage.
For ptosis.
For removal of tumors.
For removal of hair bulbs.
For removal of the tarsal cartilage.
For the restoration of lid.
For symblepharon.
For tarsorrhaphy (diminishing of the palpebral opening).
For trichiasis.
Transplantation of the cilia.

On the muscles.

Tenotomy of the muscles (strabotomy).
Advancement of a muscle.
Excision of a piece of a muscle.

On the iris.

Corelysis (Streatfield).
Detachment of posterior synechia (*Passavant*).
Iridectomy.
Iritomy.
Irito-ectomy, unintelligible —
Iridodesis.
Removal of foreign bodies from the iris.

On the lachrymal apparatus.

Destruction of the lachrymal sac.
Division of stricture of the nasal duct.
Enlargement of the punctum.
Opening of the lachrymal sac.
Probing the nasal duct.
Removal of the lachrymal gland.
Slitting up the canaliculus.

On the lens.

For depression of cataract (conching).
For extraction of cataract by the flap method.
For extraction of cataract by the Gräfe method.
For extraction of cataract in the capsule.
For extraction of cataract by the linear method.

For extraction of cataract by the Weber method.
For extraction of cataract by the sclero-corneal flap method.
For scoop extraction.
For secondary cataract.
For solution of cataract. - Discision
For removal of cataract by suction.

OPERATIONS ON THE EAR.

Catheterization of the eustachian tube.
Dilatation of the eustachian tube.
Division of the tensor tympani.
Excision of the malleus.
Insertion of artificial drum-head.
Myringo-plasty.
Paracentesis of membrana tympani.
Removal of granulations from external or middle ear.
Removal of foreign bodies from external or middle ear.
Removal of tumors from external or middle ear.
Removal of carious or necrosed bone.
Removal of tumors from the auricle.
Removal of polypi.
Trephining or puncturing the mastoid process.
Wilde's incision.

SUGGESTIONS FOR NOMENCLATURE OF DISEASES OF THE NERVOUS SYSTEM, BY H. C. WOOD, M. D., PROFESSOR OF THERAPEUTICS, UNIVERSITY OF PENNSYLVANIA.

1. Encephalitis.
   A. Cerebritis—inflammation of the brain.
   B. Meningitis.
      1. Inflammation of dura mater.
      2. Inflammation of pia mater and arachnoid.
      3. Tubercular meningitis (acute hydrocephalus).
      4. Chronic hydrocephalus.
2. Red softening of the brain (inflammation of brain).
3. Yellow softening of the brain.
4. White softening of the brain (atrophic softening).
5. Abscess of brain.
6. Atrophy of brain.
7. Hypertrophy of brain.
8. Apoplexy.
   a. Congestive.
   b. Sanguineous (cerebral-hemorrhage).
   c. Serous.
9. Multiple cerebral sclerosis.
10. Parasitic disease.
11. Malformations.
12. Syphilitic disease.
13. Cancer.
14. Tumors—according to classification.
15. Tubercular deposit.
   a. Miliary or granular tubercle.
   b. Yellow tubercle.
16. Inflammation of the sinuses of the dura mater.
17. General paralysis—paresis.
18. Sunstroke, thermic fever, insolatio, ictus solis.
19. Cerebro-spinal fever.
20. Multiple cerebro-spinal sclerosis.
21. Diseases of the cerebral arteries.
   a. Fatty and calcareous degeneration (atheroma, ossification).
   b. Aneurism, simple miliary.
   c. Impaction of coagula.
   d. 1. Thrombosis—local coagula.
      2. Embolism—coagula conveyed from a distance.

Diseases of the spinal cord and its membranes.

1. Inflammation.
2. Spinal meningitis.
   a. Acute.
   b. Chronic.
3. Spinal concussion.
4. Spinal hemorrhage.
   a. Into the cord. Spinal apoplexy.
   b. Into the cord membranes.
5. Acute spinal congestion.
6. Myelitis.
   a. Acute.
   b. Chronic (with general or local softening).
7. White softening of the spinal cord.
8. Sclerosis of the spinal cord.
   a. Multiple (disseminated sclerosis).
   b. General (sclerosis of more than one region of the cord).
   c. Posterior (locomotor ataxia).
   d. Lateral (spasmodic tabes).
   e. Anterior (tabes dorsalis).
9. Polymyelitis.
   a. Acute (infantile paralysis).
   b. Chronic (progressive muscular atrophy in some of its forms).
10. Acute ascending paralysis.
11. Paraplegia (to be used only when pathology and nature of case is uncertain).
12. Spinal tumors (arranged in accordance with general section).
13. Spinal syphilis.
14. Malformations.

Diseases of medulla oblongata.

1. Inflammation.
   a. Acute.
   b. Chronic.
2. White softening.
3. Apoplexy.
4. Tumors.
5. Glosso-labial pharyngeal paralysis.

Diseases of the nerves.

1. Inflammation, neuritis.
2. Atrophy.
   a. Disseminated neuritis.
   b. Progressive muscular atrophy, one variety.
3. Neuroma.
4. Paralysis, paralysis agitans.
5. Hemiplegia.
6. Paraplegia.
7. Local paralysis.
   a. Facial paralysis.
   b. Scrivener's palsy.
8. Diphtheritic paralysis.
9. Lead palsy.
10. Paralysis following poisoning.
11. Paralysis following acute diseases not of the nervous system.

Functional diseases of the nervous system.

1. Tetanus.
2. Hydrophobia.
3. Infantile convulsions.
4. Epilepsy.
   a. Epileptic vertigo—Petit mal.
5. Convulsions.
6. Spasms of muscle.
7. Laryngismus stridulus—spasmodic croup. Spasm of the glottis. Child-crowing.
8. Shaking palsy.
9. Mercurial tremor.
10. Chorea. (St. Vitus' dance.)
   a. Acute.
   b. Chronic.
11. Chorea major.
12. Hysteria.
13. Spinal irritation.
14. Catalepsy.
15. Syncope.
16. Neuralgia.
   a. Facial-Tic doloreaux.
   b. Brow ague. Hemicrania.
   c. Sciatica.
   d. Pleurodynia.
   e. Irritable stump.
17. Hyperæsthesia.
18. Anæsthesia.
19. Delirium tremens.
20. Hypochondriasis.

Disorders of the intellect.

1. Mania.
   a. Acute.
   b. Chronic.
2. Melancholia.
3. Dementia.
   a. Acute
   b. Chronic.
4. Idiocy—congenital.
5. Imbecility—congenital.

SUGGESTIONS AS TO DISEASES OF THE FEMALE ORGANS OF GENERATION IN THE UNIMPREGNATED STATE, NUMBERED ACCORDING TO THE NOMENCLATURE OF DISEASES OF THE ROYAL COLLEGE OF PHYSICIANS OF LONDON, BY JAMES R. CHADWICK, M. D., SECRETARY AMERICAN GYNAECOLOGICAL SOCIETY.

Diseases of the ovary. (Page 64.)

No. 631. I question whether it be proper to call *abscess* a distinct disease of the ovary in distinction to *inflammation* when it must be regarded merely as a later stage of the same process or disease (inflammation). The same criticism applies equally to Nos. 643, 651, 672.

No. 636, 637. It seems to me important not to suggest different pathological processes in these two terms. I would make them rather 636, "*Simple cystic tumor*," and 637, *complex cystic tumor*, or, better still, have but one term to embrace the two inasmuch as the *complex tumor* is a later (and accidental) development of the simple cyst.

"*a*. With intracystic growths" makes a distinction, which is of no consequence.

"No. 642. Malformations" hardly seems to include the supernumerary (3d) ovary, recently described and figured by Winckel of Dresden, which should therefore be assigned a special group.

I have an impression that pathologists recognize a "cystic degeneration of the ovary as something different from the "cystic tumor"; if this be so, the group should also be recognized, as the condition is by no means rare.

"Sarcoma" should be a recognized group, as a number of cases of this disease of the ovary have been placed on record.

Diseases of the fallopian tube.

No. 643. "Abscess." "*Inflammation*" (suppurative, if necessary) would better indicate the pathological process and would be quite as useful from a clinical standpoint. This should be analogous to inflammation of the vagina (vaginitis), &c.

No. "644, Dropsy," and "647, Cyst," I understand as referring to the same pathological condition; if so, one should be stricken out.

No 649. "Hernia" may occur, but is unknown to me.

Diseases of the broad ligament.

No. 650. "Inflammation:"

a. Pelvic peritonitis.

b. Pelvic cellulitis.

I would omit the qualifying adjective (pelvic) in these two classes as being too comprehensive in its signification. With the adjective the headings *a* and *b* are not merely "varieties" of "inflammation of the broad ligament."

No. 651. "Abscess" is a common disease, but is merely one of the results of inflammation, yet I can see that there may be some necessity and advantage in retaining the group. This case is not analogous to 643, which I regard as very objectionable.

No. 653. "Periuterine or pelvic hematocele." The adjectives here are too comprehensive. The heading had better be simply "hematocele." The word "periuterine" is objectionable, as being a compound of one Greek and one Latin word. Why not "perimetric?"

"Lymphangitis" and "varicose veins" should be inserted. The former occurs idiopathically, and likewise as a result of septic absorption. The latter has been recently described in the Boston Medical and Surgical Journal; and quite recently Adelaide Neilson is said to have died of the rupture of a varicose vein in the broad ligament.

Diseases of the uterus, including the cervix.

No. 656. "Granular inflammation." Is not this a variety of "catarrh," the pathological process involved in both being an inflammation of the mucous membrane lining the cavity of the organ (endometritis cervicitis)?

No. 657. "Abrasion" suggests a too rapid action of the causative agent. "Erosion" seems to me a better term.

No. 658. "Ulcer" is a term now pretty generally given up. The only "ulcers" now recognized being malignant or syphilitic.

No. 660. "Utero-vesical fistula" is not comprehensive enough. Make the heading "fistula" with varieties: *a*, utero-vesical; *b*, utero-ureteral; *c*, utero-rectal; *d*, utero-intestinal.

Nos. 661, 662. "Strictures." I would have "stricture of the canal" as principal heading, with varieties: "*a*, stricture of the internal os"; "*b*, stricture of the external os."

No. 665. "Hypertrophy." Would it not be well to recognize two varieties—*a*, subinvolution; *b*, hyperplasia (Thomas)?

No. 666. "Atrophy." Why not make two varieties here: *a*, hyper-involution; *b*, senile atrophy?

"Sarcoma" should be recognized as a group.

"Ecchinococci" should also be recognized. I have seen a case in Germany.

No. 669. "Malformations." Atresia is not mentioned on pp. 124 and 125, though a well known congenital condition. Lists on pp. 124 and 125 are very imperfect, as will be shown later.

Syphilitic manifestations (chancre on the vaginal portion, &c.) must be indicated. Non-specific warts may occur on the vaginal portion. I have seen them.

Diseases of the vagina.

No. 672. "Abscess" is unknown to me. Abscesses discharging into the vagina and suppurative vaginitis are familiar.

No. 674, 675, 676. Better make the chief heading "fistula" with varieties: *a*, vaginal (which, I suppose, refers to fistula running from the vagina to the perineum and other neighboring external parts); *b*, vesico-vaginal; *c*, urethro-vaginal; *d*, uretero-vaginal; *e*, recto-vaginal.

No. 677. "Hernia." Prolapse seems to me a more generally recognized term.

No. 678. "Non-malignant tumors." Varieties of this should be; *a*, "fibroid tumors" (of which I have had one case), and *b*, cysts, a well known morbid formation.

Sarcoma has, I think, also been described in the vagina.

Vaginismus is omitted.

No. 679 *a*. "Malformations." "Transverse septum" should be recognized (I have lately had a case at the upper part of the canal), and is not referred to on pp. 124, 125.

Non-specific warts sometimes occur throughout the vagina.

Diseases of the vulva.

No. 683. "Abscess." This occurs in the cellular tissue or integument but especially as a result of inflammation of the vulvo-vaginal (Bartholinus) glands. A separate heading should be made of "Inflammation of the vulvo-vaginal glands." Occlusion of the ducts of these glands often gives rise to a cystic condition of the glands, the contents being occasionally pus; but often (in chronic states) serum. Some classification of these cysts should be made, analogous to cyst or dropsy of the fallopian tube.

No. 686, 687. Are not "occlusion" and "imperforate hymen" identical conditions, hence confusing?

(593 *b*.) "Condyloma." This refers, I presume, to non-specific warts.

"Chancroid" should be recognized.

"Laceration" (see 679) should be recognized.

Functional diseases of the female organs of generation.

No. 690. "Amenorrhœa." The following additional varieties should be included:

e. From hyperinvolution of the uterus.

f. From premature menopause.

g. From perverted or deficient nerve power (as seen in those women who, without anemia or other indirect cause, cease to menstruate and grow fat).

Dyspareunia (Barnes) is needed to indicate painful coitus from various causes.

The "hystero-neuroses" are a well-recognized class of diseases, which should not be overlooked; also chloasma uterinum.

"Sterility" should be given.

Masturbation should be given.

Erotomania should be given.

Diseases of the urinary system.

"Acute parenchymatous nephritis," "chronic Bright's disease," both should be given; also, acute or chronic cystitis.

Disorders of the generative system.

No. 697. "Rheumatism of the uterus" seems to me rather a cloak for ignorance, and hence objectionable, than a veritable disease.

No. 698. "Hysteralgia" should, for "partial uterine contractions," be given as a variety of this heading, or of the next (699).

No. 702. "Displacements of the uterus" should have an additional varieties of anteversion, or rather, anterior prolapse of the uterus, described in Germany as "pendulous abdomen." 6. Hernia I don't understand as distinguished from "prolapse." "Separation of the pubic symphysis" needs insertion, and I believe it a pathological condition arising during pregnancy, although generally not recognized until the patient rises from childbed.

AFFECTIONS CONNECTED WITH PREGNANCY.

Disorders of the nervous system.

Should not "nausea and vomiting" be inserted under this heading? "Convulsions" should have two recognized varieties, nervous (hysterical) and eclamptic (uræmic).

Disorders of the circulatory system.

Serous exudation "ascites" is unknown to me as accompanying pregnancy, unless caused by cardiac, hepatic, or renal disease. Embolism, thrombosis, air in the circulatory system, all need mention; perhaps also apoplexy.

Disorders of the digestive system.

"Hernia" I have seen as a complication of pregnancy.

Affections connected with parturition.

No. 708 should read "mechanical obstacle to the *expulsion of the fœtus*." To the varieties should be added:

"From locked heads of twins," "from pessary in the vagina," "hour-glass contractions of the uterus," retroflexion of the uterus." I have had a case at time of labor preventing delivery.

No. 715. "Inversions of the uterus" should be transferred to "affections consequent on parturition."
No. 716. "Convulsions" should have as varieties, "*a*, nervous" (hysterical), and "*b*, eclamptic."

Affections consequent on parturition.

No. 132. "Puerperal fever" should have varieties "*a*, septicæmia (pyæmia)," "*b*, peritonitis," "*c*, lymphangitis."
No. 719, with its two varieties, is unnecessary.
Nos. 660, 675, 676 should all be included under "fistulæ" as varieties "*a*, utero-urethral"; "*b*, utero-vesical"; "*c*, utero-intestinal"; "*d*, utero-rectal"; "*e*, vesico-vaginal"; "*f*, vesico-urethral"; "*g*, recto-vaginal."
"Death and putrefaction of the fœtus" might be added, also, "retention of the placenta or membranes," "fissure of the anus," and "fistula in ano."

Diseases of the female breast.

Add "eczema of the nipple," and "galactocele."

Congenital malformations

Of the female organs of generation, pp. 124, 125.
Ovary, add "supernumerary."
External organs, add "infantile type."

Malformations of uterus.

Uterus duplex and vagina duplex.
Uterus duplex and vagina simplex.
Uterus unicornis.
Uterus bicornis.
Uterus simplex and vagina duplex.
Uterus duplex and vagina duplex, with atresia of one vagina.
Infantile uterus.

ADDENDA.

Addison's disease has been reported as a complication of pregnancy.
After-pains.
Amaurosis.
Amnion, dropsy of.
Chlorosis.
Hystero-epilepsy.
Heart disease in pregnancy.
Herpes in pregnancy.
Lochia offensive.
Parotiditis in pregnancy.
Uterine phlebitis.
Placenta prævia.
Pregnancy conical.
Puerperal lactosuria.
Puerperal pernicious anemia.
Puerperal tetanus.
Puerperal scarlatina.
Rape.
Coccygodynia.
Wolffian body.

APPENDIX B.

[Form of weekly report of mortality to be made on postal card.]

REPORT OF DEATHS IN ____________

for the week ending Saturday noon, ____________, 1880.

[Please note any mortality from unusual causes not specified in this blank. Please report cases of small-pox, and the prevalence, to a great extent, of any disease.]

Causes of death.	Deaths. White.	Deaths. Colored.
Accidents of all kinds		
Cerebro-spinal meningitis		
Consumption (phthisis pulmonalis		
Croup		
Diarrhœal diseases		
Diphtheria		
Erysipelas		
Fever: Typhoid		
Fever: Malarial		
Fever: Scarlet		
Acute lung diseases: Pneumonia		
Acute lung diseases: Congest'n of lungs		
Acute lung diseases: Bronchitis, acute		
Acute lung diseases: Pleurisy		
Measles		
Puerperal diseases		
Small-pox		
Whooping-cough		
Population		
under 5 years		
Deaths from all causes		
Deaths under 5 years		

REMARKS.

(Signature.) ____________.

APPENDIX C.

TABLE I.

Cause of death (see note A).	Color (see note B).	Sex (see note C.)	Total.	Under 1 year.	1 to 2.	2 to 3.	3 to 4.	4 to 5.	Total under 5.	5 to —	10 to —	15 to —	20 to —	25 to —
Small-pox	White	Male												
		Female												
	Colored	Male												
		Female												
Measles	White	Male												
		Female												
	Colored	Male												
		Female												

NOTE A.—To permit of comparison with the tables in the census and in foreign statistical tables, *e. g.*, those of the Registrar general of England, the groups of ages above 5 years should not be larger than by quinquennial periods.
NOTE B.—W., White; C., Colored. American, Irish, German, &c., to be added or substituted according to the proportion of these races present.
NOTE C.—It will save space and cost in printing to place the distinctions of race and sex at the side of the page in connection with the name of the disease, as this table, instead of at the top in connection with the several ages, as is sometimes done.

TABLE II.

Causes of death, &c. (see note A).	Color (see note B).	Sex.	Jan. Deaths under 5 years.	Jan. Total deaths.	Feb. Deaths under 5 years.	Feb. Total deaths.	March. Deaths under 5 years.	March. Total deaths.	April. Deaths under 5 years.	April. Total deaths.	May. Deaths under 5 years.	May. Total deaths.	June. Deaths under 5 years.	June. Total deaths.	July. Deaths under 5 years.	July. Total deaths.	Aug. Deaths under 5 years.	Aug. Total deaths.	Sept. Deaths under 5 years.	Sept. Total deaths.	Oct. Deaths under 5 years.	Oct. Total deaths.	Nov. Deaths under 5 years.	Nov. Total deaths.	Dec. Deaths under 5 years.	Dec. Total deaths.
Small-pox	White	Male																								
		Female																								
	Colored	Male																								
		Female																								
Measles	White	Male																								
		Female																								
	Colored	Male																								
		Female																								

NOTE A.—The following heads are suggested as those which will be most generally used in this column in the table to be published: Small-pox, scarlet fever, measles, whooping-cough, diphtheria, typhoid fever, malarial fevers, erysipelas, diarrhœal diseases, consumption, all other tubercular diseases, rheumatism and gout, diseases of the nervous system, diseases of the circulatory system, croup, pneumonia, acute bronchitis, all other diseases of the respiratory organs, diseases of the digestive organs, diseases of the urinary and generative organs (for each sex), puerperal diseases, total deaths from all diseases, suicide, homicide, accidents and injuries, poisoning, total deaths from all causes.

NOTE B.—American, Irish, German, &c., to be added to or substituted for "white," "colored," according to the proportions of these races present.

TABLE III.

Cause of death.	Social relations. Married.	Single.	Widowed.	Unknown.	Occupations. Bakers.	Blacksmiths.	Carpenters.	Cultivators of the earth.	Cooks.	Coopers.	* * *	* * *
Small-pox												
Scarlet fever												
* * *												

APPENDIX D.

Forms of tables taken from Registration Reports, the source being indicated on each table as follows, viz:

District of Columbia. From "Report of the Health Officer of the District of Columbia." Washington, 1880.

England. From "Fortieth Annual Report of the Registrar General of Births, Deaths, and Marriages in England." London, 1879.

Massachusetts. From "Thirty-seventh Report to the Legislature of Massachusetts relating to the Registry and Return of Births, Marriages, and Deaths." Boston, 1879.

Michigan. From "Eighth Annual Report relating to the Registry and Return of Births, Marriages, and Deaths in Michigan." Lansing 1880.

Providence, R. I. From "Twenty-fifth Annual Report upon the Births, Marriages, and Deaths in the City of Providence." Providence, 1880.

These forms may be conveniently classified as follows, although, of course, the groups overlap, and most of the forms belong in at least two groups.

Group I, including Forms 1 to 5, relates primarily to the causes of death.

Group II, including Forms 6 to 11, relates mainly to the influence of age.

Group III, including Forms 12 to 15, relates mainly to the influence of month or season.

Group IV, including Forms 16 to 20, relates mainly to the influence of race or nativity.

Group V, including Forms 21 to 32, relates mainly to the influence of locality.

Group VI, including Forms 33 to 35, relates mainly to the influence of occupation.

Group VII, including Forms 36 to 50, relates mainly to studies of special diseases.

FORM 1.

Causes of death, by sex and age. England.

Class.	Cause of death.	Males. All ages.	Males. Ages at death. Total under 1 year.	1	* *	Total under 5 years.	5	* *	95 and upward.	Females. All ages.	Females. Ages at death. Total under 1 year.	1	* *	Total under 5 years.	* *	* *	95 and upward.
	All causes																
	Specified causes																
	CLASSES.																
I	Zymotic diseases																
	* * * *																

In this table the ages are given by single years up to 5, then by groups of five years to 25, after that by groups of ten years.

FORM 2.

Causes of death, by sex and month, and by sex and age. Massachusetts.

NOTE.—Michigan uses the same form, but gives the years of ages in groups of five throughout.

Sex.	Deaths.				Months.													Causes of death.	Ages.											
	Sex.																													
	Males.	Females.	Unknown.	Totals.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Unknown.		Under 5.	5 to 10.	10 to 15.	15 to 20.	20 to 30.	30 to 40.	40 to 50.	50 to 60.	60 to 70.	70 to 80.	Over 80.	Unknown.
Females																		Abortion												
Males																		Abscess												
Females																		....do												
Males																		* *												
Females																														

FORM 3.

Causes of death, by months, color, and sex; by age, color, and sex; and by social relations, color, and sex. District of Columbia.

Cause of death.	Total deaths from each cause.	Per cent. of each cause to total mortality.	Death-rate.		Recapitulation.														18—.											
			Deaths per 100 inhabitants.		Total by color and sex.				Total by color.		Total by sex.		Total under 5 years.						July.				* * *				Total first quarter.			
					W.		C.						W.		C.				W.		C.		W.		C.		W.		C.	
			W.	C.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	Total.	Per cent. of each cause to total mortality.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
CLASS 1.—ZYMOTIC DISEASES.																														
Order 1.—Miasmatic.																														
* * * *																														
Total miasmatic diseases.																														

Cause of death.	Age of decedent.									Social relations.								
	Under 1 year.				* * *		5 to 10 years.	10 to 20 years.	* * *	Above 100 years.	Married.				Single.		Widow or widower.	Unknown.
	W.		C.								W.		C.		W.	C.		
	M.	F.	M.	F.							M.	F.	M.	F.				
CLASS 1.—ZYMOTIC DISEASES.																		
Order 1.—Miasmatic.																		
* * * *																		
Total miasmatic diseases.																		

FORM 4.

Causes of death.**—Comparative mortality. Exhibiting the number of deaths from special causes (nosologically arranged) during each of the five years* **1874, 1875, 1876, 1877,** *and* 1878, *with the number of deaths, annually, to* 100,000 *population; also the number and percentage of deaths during the* ***five years 1874 *to* 1878, *and during the entire registration period of thirty-seven years and eight months ending December* 31, 1878, *still-births included.* ***Massachusetts.***

Deaths.							Causes of death.	Deaths to 100,000 population.					Percentage of all deaths.	
1874.	1875.	1876.	1877.	1878.	5 years, 1874–'78.	37 years and 8 months ending Dec. 31, 1878.		1874.	1875.	1876.	1877.	1878.	5 years, 1874–'78.	37 years and 8 months ending Dec. 31, 1878.
							All causes							
							Special causes							

FORM 5.

Causes of death registered in Massachusetts for each of the twenty-two years, 1857 *to* 1878.

Class.	Causes of death.	1857.	1858.	1859.	1860.	1861.	1862.	1863.	1864.	1865.	1866.	1867.	1868.	1869.	1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.	1878.
	All causes																						
	Special causes																						

Form 6.

Deaths registered at different ages in each of the —— years 18— to 18—; males and females. England.

[Note.—Ages given by single years up to 5, then by quinquennial periods to 25, then by decennial periods.]

Total.	All ages.	Ages at death—males.								Year.	All ages.	Ages at death—females.							
		Under 1.	1.	***.	Under 5 years.	5.	***.	95 and upward.	(?)			Under 1.	1.	***.	Under 5 years.	5.	***.	95 and upward.	(?)
18— 18— **																			

Form 7.

Mortality per 1,000, at twelve groups of ages, in —— years, 18— to 18—; females. England.

Years.	Ages—females.				
	All ages.	0.	5.	***.	95 and upward.
	Mean of 40 years.				
18— to 18—					
	Means of 10 years.				
18— to 18— .... 18— to 18—					
	Means of 5 years.				
8 years, 18— to 18— .... 5 years, 18— to 18— .... * * * .... 2 years, 18— to 18—					

Same distribution of ages as in Form 6.

Form 8.

Annual rate of mortality per 1,000 persons living, at twelve groups of ages, in each of the registration counties during 18—. England.

Registration counties.	All ages.	0.	5.	10.	**.	85 and upward.
England. Average annual rate in 25 years, 18— to 18—....................						
England, Div. I. London						

Same distribution of ages as in Form 6.

Form 9.

Exhibiting by sex, and by age in periods of years, the number and proportion of persons returned as having died in —— during the year 18—; also the excess of persons of each sex. Michigan.

Ages in years and periods.	Number of deaths, 18—.				Per cent. of deaths at each age to total at all ages.			Per cent. of each sex to total of both sexes.				Excess of the sexes by number.		Males to 100 females.
										Excess.				
	Total.	Males.	Females.	Unknown.	Total.	Males.	Females.	Males.	Females.	Males.	Females.	Males.	Females.	
All ages														
Under 1 .... 1 to 2 .... * * * .... Under 5 .... 5 to 10 .... * * * .... Unknown ages														

Form 10.

Exhibiting, for the State and counties of ——, the average age of inhabitants of each sex in 18—, the number of deaths returned as having occurred at all ages, from old age, of all aged 70 and over, and of all aged under 5 in 18—; the per cent. of deaths from old age, of all aged 70 and over, and of all aged under 5, to deaths at all ages; also the inhabitants in 18— aged under 5 years, and per cent. to inhabitants at all ages. Michigan.

State and counties.	Average age of inhabitants June 1, 18—.		All ages.	Old age.		Aged 70 and over.		Decedents aged under 5.		Inhabitants in 18— aged under 5.	
	Males.	Females.	Number of deaths, 18—.	Number of deaths.	Per cent. to deaths at all ages.	* * *	* * *	* * *	* * *	* * *	* * *
State.											
A ——											
* * *											

Form 11.

Relation of age to month of death. Michigan.

Deaths, by ages, in periods of years.		Year 18—.	Months.											
			Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
All ages.														
Under 1	Number													
	Per cent. of all ages													
	Per cent. of deaths, 18—													
Under 5	Number													
	Per cent. of all ages													
	Per cent. of deaths, 18—													
5 to 10	Number													
	Per cent. of all ages													
	Per cent. of deaths, 18—													
10 to 20	Number													
	Per cent. of all ages													
	Per cent. of deaths, 18—													
20 to 50	Number													
	Per cent. of all ages													
	Per cent. of deaths, 18—													
50 and over	Number													
	Per cent. of all ages													
	Per cent. of deaths, 18—													
Unknown ages.	Number													
	Per cent. of all ages													
	Per cent. of deaths, 18—													

Form 12.

Exhibiting, by sex and by months, the number returned as having died in ——, during the year 18—, at each and every age, the age stated in twelfths of a year for those under one, and in years for those over one, year of age. Michigan.

Ages, in years.	Sex.	Year 18—.	Months, 18—.												
			Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Unknown.
Under 1-12	**Totals**														
	Males														
	Females														
	Unknown														
* * *	* * *														
	* * *														
	* * *														
	* * *														
1	**Totals**														
	Males														
	Females														
	Unknown														
2	* * *														
	* * *														
	* * *														
	* * *														

Form 13.

The months of birth and death of children born in 18—, who died under one year of age. Michigan.

Months of births, 18—.	Births, 18—; died under 1 year.	Months of death, 18—.												Months of death, 18—.												Per cent. of decedents aged under 1 month.
		January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	
Born in 18—; died aged under 1 year																										
January																										
February																										
* * *																										
Deaths at each age. { No. of deaths																										
Deaths at each age. { Ages in months																										

Form 14.

Season and disease. Providence, R. I.

Causes of death.	January.	February.	March.	First quarter.	April.	May.	June.	Second quarter.	July.	August.	September.	Third quarter.	October.	November.	December.	Fourth quarter.	Whole year.
Accidents (all kinds)																	
Apoplexy																	
Brain, diseases of																	
Bronchitis																	
Cancer (all kinds)																	
Child-birth and puerperal diseases																	
Cholera infantum																	
Cholera morbus																	
Consumption																	
Convulsions																	
Croup																	
Diarrhœa, acute and chronic																	
Diphtheria																	
Dysentery																	
Enteritis																	
Erysipelas																	
Fever, typhoid																	
Heart, diseases of																	
Whooping-cough																	
Hydrocephalus																	
Insanity																	
Intemperance and delirium tremens																	
Kidney, diseases of																	
Liver, diseases of																	
Marasmus																	
Measles																	
Meningitis, cerebro-spinal																	
Old age and senile gangrene																	
Paralysis																	
Peritonitis																	
Pneumonia and congestion of lungs																	
Scarlatina																	
Suicide																	
Teething																	
Unknown																	
Other causes as given																	
Totals																	

Form 15.

Deaths by age and parentage in each month 18—. Providence, R. I.

Divisions of the year.	Divisional periods of life.														
	Under 1.	1 to 2.	2 to 5.	5 to 10.	10 to 15.	15 to 20.	20 to 30.	30 to 40.	40 to 50.	50 to 60.	60 to 70.	70 to 80.	80 to 90.	90 to 100.	All ages.
American parentage.															
January															
February															
March															
First quarter															
* * *															
Whole year															
Foreign parentage.															
January															
February															
March															
First quarter															
* * *															
Whole year															
Total American and foreign															

FORM 13.

The months of birth and death of children born in 18—, who died under one year of age. Michigan.

Months of births, 18—.	Births, 18—; died under 1 year.	Months of death, 18—.												Months of death, 18—.												Per cent. of decedents aged under 1 month.
		January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	
Born in 18—; died aged under 1 year...																										
January																										
February																										
* * *																										
Deaths at each age. { No. of deaths....																										
Deaths at each age. { Ages in months.																										

FORM 14.

Season and disease. Providence, R. I.

Causes of death.	January.	February.	March.	First quarter.	April.	May.	June.	Second quarter.	July.	August.	September.	Third quarter.	October.	November.	December.	Fourth quarter.	Whole year.
Accidents (all kinds)																	
Apoplexy																	
Brain, diseases of																	
Bronchitis																	
Cancer (all kinds)																	
Child-birth and puerperal diseases																	
Cholera infantum																	
Cholera morbus																	
Consumption																	
Convulsions																	
Croup																	
Diarrhœa, acute and chronic																	
Diphtheria																	
Dysentery																	
Enteritis																	
Erysipelas																	
Fever, typhoid																	
Heart, diseases of																	
Whooping-cough																	
Hydrocephalus																	
Insanity																	
Intemperance and delirium tremens																	
Kidney, diseases of																	
Liver, diseases of																	
Marasmus																	
Measles																	
Meningitis, cerebro-spinal																	
Old age and senile gangrene																	
Paralysis																	
Peritonitis																	
Pneumonia and congestion of lungs																	
Scarlatina																	
Suicide																	
Teething																	
Unknown																	
Other causes as given																	
Totals																	

FORM 15.

Deaths by age and parentage in each month 18—. Providence, R. I.

Divisions of the year.	Divisional periods of life.													
	Under 1.	1 to 2.	2 to 5.	5 to 10.	10 to 15.	15 to 20.	20 to 30.	30 to 40.	40 to 50.	50 to 60.	60 to 70.	70 to 80.	80 to 90.	[illegible] to 100.
American parentage.														
January														
February														
March														
First quarter														
* * *														
Whole year														
Foreign parentage.														
January														
February														
March														
First quarter														
* * *														
Whole year														
Total American and foreign														

FORM 20.

Difference in years between the average age of American and foreign decedents. Providence, R. I.

Months.	18—.			23 years, 18— to 18—.		
	Average age.		Difference.	Average age.		Difference.
	American.	Foreign.		American.	Foreign.	
January						
February						
* * *						
Whole year						

FORM 21.

Area in statute acres, population, 18—, deaths from several causes, and inquest cases in the year 18—, in the divisions, counties, and districts. England.

Divisions and registration counties.	Area in statute acres.	Population, 18—.	Deaths from several causes in 18—.																		Inquests.
			Small-pox.	Measles.	Scarlet fever.	Diphtheria.	Whooping-cough.	Typhus fever.	Enteric or typhoid fever.	Simple continued fever.	Erysipelas.	Metria or puerperal fever.	Childbirth.	Influenza.	Dysentery.	Diarrhœa.	Cholera.	Phthisis or consumption.	Diseases of respiratory organs.	Violence.	

FORM 22.

Deaths of males from different causes in each of the registration counties in the year 18—. England.

Class.	Causes of death.	Males.											
		Division I.			Division II.					Division III.			
	All causes												
	Specified causes												
	(Classes.) * * *												

Same form as above for females.

FORM 23.

Abstract of marriages, births, and deaths, 18—; marriages, births, and deaths, 18—; districts and births and deaths, 18—; sub-districts. England.

Districts and sub-districts.	Area in statute acres.	Population, 18—.	Total.		Births.				Deaths.		Excess of births over deaths.
			Births.	Deaths.	Including illegitimate births.		Illegitimate births.				
					Males.	Females.	* * *	* * *	* * *	* * *	

FORM 24.

Deaths registered in the public institutions of —— in the year 18—. England.

Divisions and registration counties.	Total number of institutions.	Total deaths in all institutions.	Workhouses. Number of institutions.	Workhouses. Deaths. Persons.	Workhouses. Deaths. Males.	Workhouses. Deaths. Females.	Hospitals. Number of institutions.	Hospitals. Deaths. Persons.	Hospitals. Deaths. Males.	Hospitals. Deaths. Females.	Lunatic asylums. Number of institutions.	Lunatic asylums. Deaths. Persons.	Lunatic asylums. Deaths. Males.	Lunatic asylums. Deaths. Females.
England														
DIVISIONS.														
* * *														
* * *														
* * *														

FORM 25.

Deaths at different ages registered in the year 18— in the divisions and registration counties. England.

	Divisions and registration counties.	Males. Total births.	Males. Total deaths.	Ages at death. Under 1 year.	1 year.	2 years.	* * *	Under 5 years.	5 years.	* * *	* * *	95 years and upwards.
	England											
	Divisions:											
I.	* * *											
II.	* * *											

FORM 26.

Births, marriages, and deaths registered during the year 188–. Massachusetts.

Counties and towns.	Population, State census 1875.	Births. Whole number.	Births. Sex. Males.	Births. Sex. Females.	Births. Sex. Unknown.	Births. Parentage. American.	Births. Parentage. Foreign.	Births. Parentage. American father and foreign mother.	Births. Parentage. Foreign father and American mother.	Births. Parentage. Unknown.	Marriages. Couples.	Marriages. Nativity. American.	Marriages. Nativity. Foreign.	Marriages. Nativity. American mother and foreign father.	Marriages. Nativity. Foreign mother and American father.	Marriages. Nativity. Unknown.	Deaths. Persons.	Deaths. Sex. Males.	Deaths. Sex. Females.	Deaths. Sex. Unknown.	Deaths. Number whose ages are registered.	Deaths. Age. Aggregate.	Deaths. Age. Average.
Barnstable																							
Brewster																							
Chatham																							
* * *																							

FORM 27.

***Causes of death.**—Nosological arrangement exhibiting the number of deaths in each county from special causes (statistically classified) during the year 18—, still births included. Massachusetts and Michigan.*

Causes of death.	State.	Barnstable.	Berkshire.	Bristol.	* * *	* * *	* * *	* * *	* * *	* * *	* * *	* * *	* * *	* * *
All causes														
Specified causes														

FORM 28.

General abstract for the 14 *years* 1865 *to* 1878, *exhibiting the number of births, marriages, and deaths registered for the several counties and towns of Massachusetts for the* 14 *years* 1865 *to* 1878, *distinguishing the sex of children born and of persons who died in each town, and the average age of those deceased in each county during the period specified. Massachusetts.*

State and county.	Births.				Marriages. No. couples.	Deaths.			
	Persons.	Sex.				Persons.	Sex.		
		Males.	Females.	Unknown.			Males.	Females.	Unknown.
MASSACHUSETTS.									
Barnstable									
* * * *									

FORM 29.

Deaths—14 *years*, 1865 *to* 1878—*distinguishing by counties, by months, and by sex the registered number of persons who have died during the* 14 *years* 1865 *to* 1878; *also, for the entire State the percentage of the numbers in each month (distinguishing sex) to the total number. Massachusetts.*

14 years. Months.	Sex.	Percentage.	State.	Barnstable.	Berkshire.	Bristol.	* *	* *	* *	* *	* *	* *	* *	* *	* *	*
14 years	Males															
	Females															
	Unknown															
	Totals															
January	Males															
	Females															
	Unknown															
	Totals															
* * *																

FORM 30.

Exhibiting for the State and counties, by sex, the number of deaths returned as having occurred in —— *during the year* 18—, *and in each month of the year; also the number of deaths at each period of age. Michigan.*

State and counties.	Sex.	Months, 18—.														Ages, 18—.						
		Year 18—.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Unknown.	Under 5.	5 to 10.	10 to 15.	15 to 20.	20 to 25.	* * *	* * *
State	Total																					
	Males																					
	Females																					
	Unknown																					
A——	Total																					
	Males																					
	Females																					
	Unknown																					
* * *																						

FORM 31.

Distinguishing by counties, by months, and by sex the registered number of persons who died during the year. Massachusetts.

Year and month.	Sex.	State.	Barnstable.	Berkshire.	Bristol.	* * *	* * *	* * *	* * *	* * *	* * *	* * *	* * *
Year	Males												
	Females												
	Unknown												
	Total												
January	Males												
	Females												
	Unknown												
	Total												

FORM 16.

Deaths in during the year 18—, distinguishing the color by number and proportion of each sex, and by sex, the per cent of deaths of each color to total of all colors, and per cent. of inhabitants of each color to total of all colors, June 1, 18—. Michigan.

Color.	Sex.	Population June 1, 18—.	Number of deaths returned for 18—.	Per cent. of deaths of each sex to total of both sexes.	Males to 100 females.	Per cent. of deaths of each color to total of all colors by sex.	Per cent. of inhabitants of each color to total of all colors by sex, June 1, 18—.	Death rate—per cent. of deaths in 18— to population in 18—.
All colors	Total							
	Males							
	Females							
	Unknown							
White	* * *							
Black	Total							
	Males							
	Females							
Mulatto	* * *							
Indian	* * *							
Unknown	* * *							
Black and mulatto	* * *							

FORM 17.

Exhibiting, by number and by sex, for the State and counties, the color of all persons returned as having died in .. during the year ending December 31, 18—. Michigan.

State and counties.	All colors, 18—.				White.				Black.			Mulatto.			Indian.			Unknown.			
	Total.	Males.	Females.	Unknown.	Total.	Males.	Females.	Unknown.	Total.	Males.	Females.	Total.	Males.	Females.	Total.	Males.	Females.	Total.	Males.	Females.	Unknown.
State																					
A—																					
B—																					
* * *																					

FORM 18.

Number and percentage at different ages, according to parentage. Providence, R. I.

Age.	American parentage, 23 years, 18— to 18—.		Foreign parentage, 23 years, 18— to 18—.		American and foreign parentage, 23 years, 18— to 18—.	
	Number of deaths.	Percentage in each division of age.	Number of deaths.	Percentage in each division of age.	Number of deaths.	Percentage in each division of age.
Under 1 year						
1 and under 2						
2 and under 5						
Total under 5						
5 and under 10						
10 and under 15						
* * *						
90 and over						
Totals						

FORM 19.

Deaths, twenty-three years, 1856 to 1878. Recapitulation: Aggregate and average age by parentage. Providence, R. I.

Twenty three years, 1856 to 1878.	American parentage.			Foreign parentage.			Total American and foreign.		
	Number of deaths.	Aggregate age.	Average age.	Number of deaths.	Aggregate age.	Average age.	Number of deaths.	Aggregate age.	Average age.
January									
February									
* * *									
Whole year									

Form 20.

Difference in years between the average age of American and foreign decedents. Providence, R. I.

Months.	18—.			23 years, 18— to 18—.		
	Average age.		Difference.	Average age.		Difference.
	American.	Foreign.		American.	Foreign.	
January						
February						
* * *						
Whole year						

Form 21.

Area in statute acres, population, 18—, deaths from several causes, and inquest cases in the year 18—, in the divisions, counties, and districts. England.

Divisions and registration counties.	Area in statute acres.	Population, 18—.	Deaths from several causes in 18—.																		Inquests.
			Small-pox.	Measles.	Scarlet fever.	Diphtheria.	Whooping-cough.	Typhus fever.	Enteric or typhoid fever.	Simple continued fever.	Erysipelas.	Metria or puerperal fever.	Childbirth.	Influenza.	Dysentery.	Diarrhœa.	Cholera.	Phthisis or consumption.	Diseases of respiratory organs.	Violence.	

Form 22.

Deaths of males from different causes in each of the registration counties in the year 18—. England.

Class.	Causes of death.	Males.												
		Division I.			Division II.					Division III.				
	All causes													
	Specified causes													
	(Classes.)													
	* * *													

Same form as above for females.

Form 23.

Abstract of marriages, births, and deaths, 18—; marriages, births, and deaths, 18—; districts and births and deaths, 18—; sub-districts. England.

Districts and sub-districts.	Area in statute acres.	Population, 18—.	Total.		Births.				Deaths.		Excess of births over deaths.
			Births.	Deaths.	Including illegitimate births.		Illegitimate births.				
					Males.	Females.	* * *	* * *	* * *	* * *	

Form 40

Exhibiting for the State and geographical divisions in 18—, by sex, the number of deaths returned as having occurred from all causes, from consumption, from pneumonia, from typhoid fever, from intermittent fever, and from diarrhœa; also the per cent. of deaths from consumption, pneumonia, typhoid fever, intermittent fever, and diarrhœa, to deaths from all causes. Michigan.

State and geographical divisions.	Sex.	All causes, 18—.	Consumption. Number of deaths.	Consumption. Per cent. to deaths from all causes.	Pneumonia. * *	Typhoid fever. * *	Intermittent fever. * *	Diarrhœa. * *
State	Total							
	Male							
	Female							
	Unknown							
Northern	Total							
	Male							
	Female							
* * * * * *	* * *							

Form 41.

Correlation of consumption and pneumonia, exhibiting the number and per cent of deaths of each sex, the difference between the sexes, and the per cent. of total deaths at each period of age from consumption and pneumonia in ———, during the year 18—. Michigan.

Ages in periods of years.	Deaths from consumption, 18—. Number. Males.	Number. Females.	Total.	Per cent. of deaths at each age to deaths at all ages.	Per cent. of the sexes. Males.	Per cent. of the sexes. Females.	Excess. Males.	Excess. Females.	Deaths from pneumonia, 18—. Number. Males.	Number. Females.	Number. Unknown.	Total.	Per cent. of deaths at each age to deaths at all ages.	Per cent. of the sexes. Males.	Per cent. of the sexes. Females.	Per cent. of the sexes. Unknown.	Excess. Males.	Excess. Females.
All ages																		
Under 5																		
* * *																		
60 and over																		
Unknown																		
Average																		

Form 42.

Exhibiting, for the year and months, by sex, the conjugal condition, occupation, and age, in periods of years, of all returned as having died from consumption in ———, during the year ending December 31, 18—. Michigan.

Months, 18—. January.	February.	March.	* * *	Unknown.	Year. 18—.	Conjugal condition.	Sex and occupation.	Ages, in periods of years, 18—. Under 5.	5 to 10.	* * *	80 and over.	Unknown.
						Total	Total deaths from consumption					
						Married						
						Single						
						Widowed						
						Unknown						
						* * *	Females					
						* * *						
						* * *						
						* * *						
						* * *	Males					
						* * *						
						* * *						
						* * *						
						* * *	Occupations unknown—Total					
						* * *						
						* * *						
						* * *						
						* * *	Occupations unknown—Females					
						* * *						
						* * *						
						* * *						
						* * *	All specified occupations—Total					
						* * *						
						* * *						
						* * *						

FORM 43.

Exhibiting, by sex, the number of children under one year of age returned as having died in ———, during the year 18—, distinguishing the months in which they died, their age, in months, at death, the months in which they were born, and whether born in the year of death or in the previous year. Michigan.

Months in which births and deaths occurred.	Number born in each month of year of death.		Number of children that died at each age, in months.													Number born in each month of year previous to year of death.			Deaths, by months.							
																			Of those born in year of death.			Of those born in previous year.			All aged under 1 year.	
	Year.	Total	Sex.	No. of each sex.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	No. of each sex.	Total.	Year.	Year.	Sex.	Total.	Year.	Sex.	Total.	Sex.	Total.
January	18—		Males .. Females.																							
* * * * *	* *		* * *	* *	*	*	*	*	*	*	*	*	*	*	*	*	*	*	* *	* *	* *	* *	* *	* *	* *	* *
Of those born in year of death.	18—		Males... Females.																							
			Total..																							
Of those born in previous year.	18—		Males .. Females.																							
			Total..																							
All aged under one year.	18—		Males... Females.																							
			Total..																							

FORM 44.

The average age of the inhabitants of ———, of both sexes, of each sex, and the difference between the sexes, for all living June 1, 18—, and all returned as having died during the year ending June 1, 18—, as compiled from the United States census of that date; for all returned as having died from consumption during the years 18—, 18—, 18—, 18—; for all returned as having died from all causes during the years 18— to 18—, inclusive, as shown by the registration returns; for all living aged twenty and over, as per census June 1, 18—; for all aged twenty and over whose ages and occupations were stated in the registration returns of deaths for the years 18— to 18—, inclusive, and for the native and foreign born inhabitants returned as having died during the years 18— and 18—. Michigan.

	Year ending—	Average age, in years and hundredths of a year.			
		Total.	Males.	Females.	Excess, males.
Deaths, as per census					
Living, as per census					
Deaths, as shown by registration returns					
Deaths from consumption, by registration returns					
All living aged 20 and over, per census					
All aged 20 and over whose occupations were stated in registration returns of deaths					
Deaths, as shown by registration returns					
All aged 20 and over whose occupations were stated in registration returns of deaths					
Deaths, as shown by registration returns					
Deaths from consumption, by registration returns					
All aged 20 and over whose occupations were stated in registration returns of deaths					
All who died aged 20 and over, as shown by registration returns					
"Average years of life," after the age of 20 years, plus 20 years—indicate the "average at death" of all who died aged 20 years and over					
Deaths, as shown by registration returns					
Deaths of native-born inhabitants, as shown by registration returns					
Deaths of foreign-born inhabitants, as shown by registration returns					
Deaths from consumption, by registration returns					
All aged 20 and over whose occupations * * *					
All who died aged 20 and over * * *					
Deaths as shown by registration returns					
Deaths of native-born inhabitants * * *					
Deaths of foreign-born inhabitants * * *					
Deaths from consumption * * *					
All aged 20 and over * * *					

FORM 45.

Showing total number of deaths, by color and sex, with population (estimated), for different periods of life, average ages of decedents, the number of widows and widowers, married and single, of and above the age of 20 years, percentages to total mortality, and annual death-rates per 1,000 of each class at different periods of life, for year ending June 30, 18—. District of Columbia.

Color and sex.	All ages.					5 years and over.							* * *	Social relations of, and above twenty years.								
	Estimated population.	Total deaths.	Average ages.	Death-rate per 1,000, each class.	Percentage to total mortality.	* * *	* * *	* * *	Percentage to total mortality of each class.	* * *	* * *	* * *		Widows and widowers. Total deaths.	Average ages.	Percentage to total mortality of each class.	Percentage to total mortality.	Married. * * *	* * *	* * *	* * *	Single.
White males																						
White females																						
Total white																						
Colored males																						
Colored females																						
Total colored																						
Total white and colored																						

FORM 46.

Deaths, showing nativity, duration of residence, and age of white decedents dying of the three diseases specified, and from all other causes, for the year ending June 30, 18—. District of Columbia.

Diseases.	Age of decedent.	District of Columbia.	New England States. Duration of residence. Under 1 year.	1 to 5 years.	5 to 10 years.	10 years and over.	Middle States. * * *	Maryland, West Virginia, and Virginia.	United States not specified.	Ireland.	England, Scotland, and Wales.	Germany.	All other foreign countries.
Phthisis pulmonalis, or consumption.	Under 5 yrs												
	5 to 10 yrs												
	10 to 20 yrs												
	20 to 30 yrs												
	30 to 40 yrs												
	40 and over												
Pneumonia													
Cancers													
All other diseases.													

FORM 47.

Showing deaths under one year of age, arranged monthly, according to sex and color, with percentages and death-rates, for the year ending June 30, 18—. District of Columbia.

Color and sex.	Ages. 1 day and under.	1 day to 1 week.	1 week to 1 month.	1 to 2 months.	* * *	Total.	Percentage to total mortality under 1 year of age by color and sex.
July.							
White males							
White females							
Colored males							
Colored females							
Total							

Form 36.

Deaths from several causes in 18—. Massachusetts.

State and county.	Population in 1879.	Deaths from several causes in 1878.																	
		Small-pox.	Measles.	Scarlatina.	Diphtheria and croup.	* * *	* * *	* * *	* * *	* * *	* * *	* * *	* * *	* * *	* * *	* * *	* * *	* * *	* * *
Massachusetts																			
Barnstable																			
Berkshire																			
Bristol																			

Form 37.

Deaths in ——— from ten specified causes during the year 18—, exhibiting the number of each sex, total number in each month, and at different periods of age, according to the returns. Michigan.

Sex, month, and ages.		Ten causes of death in 18—.									
		Cancer.	Cephalitis.	Croup.	Diarrhœa.	Diphtheria.	Dysentery.	Measles.	Scarlet fever.	Typhoid fever.	Whooping-cough.
Sex	Total										
	Males										
	Females										
	Unknown										
Months	January										
	* * *										
	Unknown										
	Average month										
Ages	Under 5										
	5 to 10										
	* * *										
	80 and over										
	Unknown										

Form 38.

Cerebro-spinal meningitis, &c.—Deaths returned as having occurred in ———, from cerebro-spinal meningitis, spotted fever, spinal meningitis, meningitis, and spinal fever, by months, during the year 18—, and some meteorological conditions existing at the same time. Michigan.

Months in order by number of deaths from cerebro-spinal meningitis, spotted fever, spinal meningitis, meningitis, and spinal fever, greatest number first.	Deaths from cerebro-spinal meningitis, &c., 18—.		Temperature (Fahr.), mean of three daily observations at 7 a. m., 2 p. m., and 9 p. m.			Humidity of atmosphere, &c., monthly averages.			Ozone—relative maximum = 10.		Barometer reduced to 32° Fahrenheit—average.	Rain and melted snow in inches.	Range of barometer.	
			Average range.											
	Number.	Per cent. of total.	Daily.	From day to day, 2 p. m. to 2 p. m.	Temperature.	Relative humidity or per cent. of saturation.	Force or pressure of vapor in inches.	Weight, in grains, of vapor in cubic foot of air.	Day—7 a. m. to 2 p. m.	Night—9 p. m. to 7 a. m.			Monthly and yearly.	Average daily.
Year 18—														
More than average:														
April														
March														
* * *														
* * *														
Average:														
July														
October														
* * *														
* * *														

Same table used for croup and for diphtheria.

Form 39.

Exhibiting for the State and by counties for the year 18— the number of deaths returned as having occurred from all causes—from consumption, from pneumonia, from typhoid fever, from intermittent fever, and from diarrhœa; also the per cent. of deaths from consumption, pneumonia, typhoid fever, intermittent fever, and diarrhœa, to deaths from all causes. Michigan.

State and counties.	Deaths, all causes, 18—.	Consumption.		Pneumonia.		Typhoid fever.		Intermittent fever.		Diarrhœa.	
		Number of deaths.	Per cent to deaths from all causes.	* * *	* * *	* * *	* * *	* * *	* * *	* * *	* * *
State											
A——											
* * *											
* * *											

FORM 40

Exhibiting for the State and geographical divisions in 18—, by sex, the number of deaths returned as having occurred from all causes, from consumption, from pneumonia, from typhoid fever, from intermittent fever, and from diarrhœa; also the per cent. of deaths from consumption, pneumonia, typhoid fever, intermittent fever, and diarrhœa, to deaths from all causes. Michigan.

State and geographical divisions.	Sex.	All causes, 18—.	Consumption. Number of deaths.	Consumption. Per cent. to deaths from all causes.	Pneumonia.	Typhoid fever.	Intermittent fever.	Diarrhœa.
					* * * * *	* * * * *	* * * * *	* * * * *
State	Total							
	Male							
	Female							
	Unknown							
Northern	Total							
	Male							
	Female							
* * * * * *	* * *							

FORM 41.

Correlation of consumption and pneumonia, exhibiting the number and per cent of deaths of each sex, the difference between the sexes, and the per cent. of total deaths at each period of age from consumption and pneumonia in ——, during the year 18—. Michigan.

Ages in periods of years.	Deaths from consumption, 18—. Number. Males.	Number. Females.	Number. Total.	Per cent. of deaths at each age to deaths at all ages.	Per cent. of the sexes. Males.	Per cent. of the sexes. Females.	Excess. Males.	Excess. Females.	Deaths from pneumonia, 18—. Number. Males.	Number. Females.	Number. Unknown.	Number. Total.	Per cent. of deaths at each age to deaths at all ages.	Per cent. of the sexes. Males.	Per cent. of the sexes. Females.	Per cent. of the sexes. Unknown.	Excess. Males.	Excess. Females.
All ages																		
Under 5																		
* * *																		
80 and over																		
Unknown																		
Average																		

FORM 42.

Exhibiting, for the year and months, by sex, the conjugal condition, occupation, and age, in periods of years, of all returned as having died from consumption in ——, during the year ending December 31, 18—. Michigan.

Months, 18—. January.	February.	March.	* * *	Unknown.	Year. 18—.	Conjugal condition.	Sex and occupation.	Ages, in periods of years, 18—. Under 5.	5 to 10.	* * *	80 and over.	Unknown.
						Total	Total deaths from consumption					
						Married						
						Single						
						Widowed						
						Unknown						
						* * *	Females					
						* * *						
						* * *						
						* * *						
						* * *						
						* * *	Males					
						* * *						
						* * *						
						* * *						
						* * *						
						* * *	Occupations unknown—Total					
						* * *						
						* * *						
						* * *						
						* * *						
						* * *	Occupations unknown—Females					
						* * *						
						* * *						
						* * *						
						* * *						
						* * *	All specified occupations—Total					
						* * *						
						* * *						
						* * *						
						* * *						

FORM 43.

Exhibiting, by sex, the number of children under one year of age returned as having died in ———, during the year 18—, distinguishing the months in which they died, their age, in months, at death, the months in which they were born, and whether born in the year of death or in the previous year. Michigan.

Months in which births and deaths occurred.	Number born in each month of year of death.			Number of children that died at each age, in months.												Number born in each month of year previous to year of death.			Deaths, by months.							
																			Of those born in year of death.			Of those born in previous year.			All aged under 1 year.	
	Year.	Total.	Sex.	No. of each sex.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	No. of each sex.	Total.	Year.	Year.	Sex.	Total.	Year.	Sex.	Total.	Sex.	Total.
January	18—		Males .. Females.																							
* * * *	* *		* * *	*	*	*	*	*	*	*	*	*	*	*	*	* *	* *	* *	* *	* *	* *	* *	* *	* *	* *	* *
Of those born in year of death.	18—		Males... Females. Total..																							
Of those born in previous year.	18—		Males .. Females. Total..																							
All aged under one year.	18—		Males... Females. Total..																							

FORM 44.

The average age of the inhabitants of ———, of both sexes, of each sex, and the difference between the sexes, for all living June 1, 18—, and all returned as having died during the year ending June 1, 18—, as compiled from the United States census of that date; for all returned as having died from consumption during the years 18—, 18—, 18—, 18—; for all returned as having died from all causes during the years 18— to 18—, inclusive, as shown by the registration returns; for all living aged twenty and over, as per census June 1, 18—; for all aged twenty and over whose ages and occupations were stated in the registration returns of deaths for the years 18— to 18—, inclusive, and for the native and foreign born inhabitants returned as having died during the years 18— and 18—. Michigan.

	Year ending—	Average age, in years and hundredths of a year.			
		Total.	Males.	Females.	Excess, males.
Deaths, as per census					
Living, as per census					
Deaths, as shown by registration returns					
Deaths from consumption, by registration returns					
All living aged 20 and over, per census					
All aged 20 and over whose occupations were stated in registration returns of deaths					
Deaths, as shown by registration returns					
All aged 20 and over whose occupations were stated in registration returns of deaths					
Deaths, as shown by registration returns					
Deaths from consumption, by registration returns					
All aged 20 and over whose occupations were stated in registration returns of deaths					
All who died aged 20 and over, as shown by registration returns					
"Average years of life," after the age of 20 years, plus 20 years—indicate the "average at death" of all who died aged 20 years and over					
Deaths, as shown by registration returns					
Deaths of native-born inhabitants, as shown by registration returns					
Deaths of foreign-born inhabitants, as shown by registration returns					
Deaths from consumption, by registration returns					
All aged 20 and over whose occupations * * *					
All who died aged 20 and over * * *					
Deaths as shown by registration returns					
Deaths of native-born inhabitants * * *					
Deaths of foreign-born inhabitants * * *					
Deaths from consumption * * *					
All aged 20 and over * * *					

FORM 48.

Showing location in certain sections of deaths and births not occurring in hospitals or similar institutions, with percentages, for the year ending June 30, 18—. District of Columbia.

Diseases.	City. First division. Deaths.	City. First division. Percentages.	City. First division. Deaths.	City. First division. Percentages.	City. Second division.	City. Second division.	County. First division.	County. First division.	Total deaths.	Percentages.
Phthisis pulmonalis										
Pneumonia										
Cholera infantum										
Scarlet fever										
Diphtheria										
Typhoid fevers										
Malarial fevers										
Diarrhœal diseases										
All other diseases										
Total										
Births										

FORM 49.

Showing total deaths and death-rate by color, number of decedents under one year, under 5 years, and 60 years of age and over, together with the principal causes from which these deaths have resulted; also the number of births, marriages, and still-births, stated by months, with rate per 1,000 for each, from ——, 18—, to ——, 18—, inclusive. District of Columbia.

Months.	Total deaths. White. No. of deaths.	Total deaths. White. Rate per 1,000 white population.	Total deaths. Colored. No. of deaths.	Total deaths. Colored. Rate per 1,000 colored population.	No. deaths under 1 year of age. White.	No. deaths under 1 year of age. Colored.	No. deaths under 5 years of age. * *	No. deaths 60 years of age and over. * *	Number of deaths from— Measles. * *	Scarlet fever.	Diphtheria.	Croup.	Whooping cough.	Typhoid fever.	Cerebro spinal fever.
18—.															
January															
February															
* * *															
Total deaths 18—.															

FORM 50.

Showing total deaths and death-rate by color, &c. District of Columbia.

Months.	Number of deaths from— Diarrhœal diseases. Under 5 years. White.	Diarrhœal diseases. Under 5 years. Colored.	Diarrhœal diseases. All ages. * *	Phthisis pulmonalis.	Pneumonia.	Bronchitis.	Diseases of the nervous system.	No. births reported. White. No. of births.	No. births reported. White. Rate per 1,000 white population.	No. births reported. Colored. No. of births.	No. births reported. Colored. Rate per 1,000 colored population.	No. marriages reported. White. No. of marriages.	No. marriages reported. White. Rate per 1,000 persons married white population.	No. marriages reported. Colored. No. of marriages.	No. marriages reported. Colored. * * *	No. still-births. * * * No. of still-births.	No. still-births. * * * Rate per 1,000 white population.	No. still-births. * * *	No. still-births. * * *
January																			
February																			
* * *																			
Total deaths 18—.																			
Grand total.																			

MAYOR'S OFFICE, CITY HALL,
Baltimore, March 5, 1880.

To the President and Members of the National Board of Health:

GENTLEMEN: I have this day received a certified copy of a resolution passed by the city council of Baltimore, a copy of which I herewith inclose, by which I am authorized to invite the National Board of Health to institute and conduct, under its auspices, a sanitary survey of the city of Baltimore, or such portions of it as they may deem necessary.

I have the honor to request that your board will make such a survey as is indicated in the resolution referred to.

Very respectfully,

FERDINAND C. LATROBE, *Mayor.*

Whereas the National Board of Health has expressed the opinion that a sanitary survey of Baltimore is important in the interest of the future health of the city: Therefore,

Be it resolved by the first and second branches of the city council of Baltimore, That his honor the mayor be, and he is hereby, requested to invite the National Board of Health to institute and conduct under its auspices a sanitary survey of the city, or such portions of it as they may deem necessary.

NATIONAL BOARD OF HEALTH,
Washington, D. C., March 8, 1880.

SIR: I have the honor to acknowledge the receipt of your communication of the 5th instant, transmitting copy of a resolution of the first and second branches of your city council inviting the National Board of Health to make a sanitary survey of your city, and to state that the papers have been referred to the executive committee of this Board.

Very respectfully,

T. J. TURNER,
Secretary National Board of Health.

Hon. F. C. LATROBE,
Mayor of Baltimore, Md.

NATIONAL BOARD OF HEALTH,
Washington, D. C., April 8, 1880.

SIR: In compliance with the request contained in a resolution of the city council of Baltimore, transmitted to this Board in your communication of March 3, the executive committee has this day appointed Dr. Charles W. Chancellor a special sanitary inspector to be assigned to the duty of making a sanitary survey of selected portions of the city, and has instructed me to communicate this fact to you, and to request that you will give to Dr. Chancellor, in conjunction with the health commissioner of the city, who has been requested to co-operate with him, such facilities and such authority as may be needed to enable them to have entrance to and make the necessary inspections.

I take occasion to recall to your remembrance the statement I made to you in a personal interview to the effect that it is entirely beyond the scope of the power of this Board to extend pecuniary aid to States or municipalities for purposes of local sanitation. It is therefore not with any view of relieving the city of Baltimore from any part of the expense of improving its sanitary condition that the partial survey about to be instituted under the auspices of this Board has been ordered by the executive committee. It is done in conformity with the provisions of the law to obtain accurate data on which the advisory function of the Board can be intelligently exercised and enforced, with the expectation that the work will be followed up by the authorities of the city to its proper conclusion.

Very respectfully, your obedient servant,

J. L. CABELL,
President National Board of Health.

General F. C. LATROBE,
Mayor of Baltimore.

NATIONAL BOARD OF HEATH,
Washington, April 8, 1880.

DOCTOR: I am directed by the executive committee of the National Board of Health to inform you that, having decided to comply with the request of the city council of Baltimore as transmitted by his honor the mayor in a communication dated March 5, addressed to this Board, it has this day appointed you a special sanitary inspector, to be assigned to the temporary duty of making a sanitary survey of selected portions of the city in conjunction with Dr. Steuart, health commissioner, so far as he may be willing to extend assistance in the way of counsel and co-operation.

You are accordingly instructed to call upon those officers and to request in behalf of this Board that they will offer you every facility in their power to enable you to perform satisfactorily the important duty which has been assigned to you. To this end I inclose a letter addressed to General Latrobe, which makes known the wishes of the Board and solicits his official co-operation. This open letter you are at liberty to read before delivering it to the mayor.

The selection of the localities to be inspected is left to your discretion after conference with Dr. Steuart, but it is suggested that the inspections should not be confined to the localities which are manifestly in the worst sanitary condition. It may be important to show that even some of the apparently best parts of the city are not exempted from dangers under the system which has heretofore prevailed of disposing of excremental filth. It is the desire of the Board that the partial survey now ordered shall demonstrate to the satisfaction of the council the imperative necessity of a general system of sewerage of Baltimore.

It is suggested that you invite the special attention of the authorities of the city to a report in the Baltimore Gazette of Thursday, April 8, of four deaths from scarlet fever in three days, with two more children dying in the same house, No. 340 East Madison street, and of the probable local cause of this great mortality as ascertained by sanitary inspection.

It is requested that in making house-to-house inspections you will use the schedules of questions contained on the blank forms which have been furnished you, but that you will also collect any other information which may be pertinent to the general objects of the survey.

The amount appropriated by the Board to be expended under your direction for this survey, including your own pay of $10 per diem while actually engaged in the performance of your duties, is strictly limited to $700. The committee feels assured that you will disburse the amount placed under your control with the utmost economy, so far as may be consistent with the attainment of the ends had in view, and that for every dollar expended there shall be an adequate service rendered.

You will certify to the correctness of all accounts forwarded to this office for settlement on forms of vouchers which will be furnished you on demand.

Very respectfully, yours,

J. L. CABELL,
President National Board of Health.

Dr. C. W. CHANCELLOR,
Baltimore, Md.

NATIONAL BOARD OF HEALTH,
Washington, September 30, 1880.

SIR: Referring to my communication of April 10, announcing the appointment by the executive committee of the Board of Dr. C. W. Chancellor as a special sanitary inspector to be charged with the duty of making a sanitary survey of selected portions of Baltimore City in compliance with a request to that effect by the city council, I have now the honor to inform you that said survey has been made in conformity with instructions from this office, and to transmit to you Dr. Chancellor's report of the same. It is pertinent to remark that Dr. Charles F. Folsom, then secretary of the State board of health of Massachusetts, who had made a special study of the methods of sewerage and disposal of the excremental filth of cities both in Europe and in this country, was appointed by this Board to consult with Dr. Chancellor in the progress of his work and in the preparation of his report, in the general conclusions of which he has expressed his concurrence. I avail myself of the occasion to say that the facts cited in this report abundantly justify the opinions expressed in the preamble and resolutions adopted by the executive committee February 6, 1880, which having been submitted to the health authorities of the State of Maryland and the city of Baltimore, and having received their concurrence, were transmitted to you as chairman of a meeting held at Rennert's Hotel on the preceding day, at which meeting a resolution was passed soliciting such expression of opinion on the part of this Board. I will add that, while the executive committee earnestly reiterates the advice then given, proper steps be *immediately* taken looking to the inauguration of a systematic sewerage of the city of Baltimore as an indispensable means of protecting the public health, it concurs with Dr. Folsom in thinking that it would be premature to recommend any particular plan until there shall have been made by competent engineers an exact topographical survey of the city, with contour-maps, in order that the problem of the carriage and final disposal of the sewage of the entire city on some uniform plan may be intelligently considered.

Very respectfully, your obedient servant,

J. L. CABELL,
President National Board of Health.

Hon. T. C. LATROBE,
Mayor of Baltimore.

seven are self-draining, and the rest *profess* to be cleaned once or twice a year. A large number of these privies drain or empty directly into Harford Run. Out of 23 houses inspected on Spring street, the Harford Run sewer may be said to bear the relation of a positive nuisance in 16 cases. It is a nuisance in the case of eight houses out of 22 at one point on Caroline street, and 9 houses out of 10 between Nos. 129 and 147 Spring street. The condition of the cellars and yards in the vicinity of this sewer indicates clearly what must be its influence sooner or later upon the health of the neighborhoods through which it flows. Fifty-eight cellars were found damp and in bad condition in this district, and the dampness existing in those on Spring street is directly traceable to the proximity of Harford Run. One cellar was not only damp but actually flooded with foul water from this source. At one point on Spring street there is also a tannery, which emits a noisome smell, and its vats empty their contents directly into the run, adding another element of filth to its already black and offensive flow.

The character of a very large proportion of the diseases which have prevailed in this district indicates that the condition of Harford Run has already begun to influence in a very marked degree the health of those subjected to its seething and poisonous exhalations. This badly constructed and disgracefully filthy drain is undoubtedly the principal cause of a majority of the cases of sickness reported, and however energetic our State and city health departments may be in the performance of their respective duties, they cannot begin to enforce the requisite amount of sanitation to protect the public from these insidious and ever pervading poisons. Their means are limited, and in the case of the State board of health their power is simply advisory.

SIXTH DISTRICT.

Eleventh ward.—The sanitary survey of a portion of this ward, which is situated in the higher and better part of the city, and contains, generally, only dwellings of the better class, embraced 118 houses, containing a total of 733 inmates, or an average of about six persons to a house. The cellars, yards, &c., of all these houses were found in good condition. Water-closets in nearly every house, which are emptied by trapped soil-pipes into a well in the yard. Sixty-four of these wells are self-draining; the remainder are cleaned as often as may be required. The supply of water in every house is derived from the city water-works.

SEVENTH DISTRICT.

Eighteenth and Nineteenth wards.—Parts of each of these two wards were inspected, but, as there was nothing of special interest in a sanitary point of view observed, it is not deemed necessary to enter into a detailed account of the inspections. As in the sixth district, a very large proportion of the privies are self-draining and for the most part exceptionally clean, as were also the cellars and yards.

Notwithstanding the fact that the privy-vaults in this and other high-lying districts are usually self-draining and very generally in excellent condition, the great importance of avoiding all sources of unwholesome and offensive effluvia and of preserving the substrata of the city in a dry and clean condition creates a severe necessity for relinquishing altogether these cesspools, which can only be done by establishing a proper system of sewerage.

OVERCROWDED HOUSES.

Apart from the general conclusions to which we are led by the data from the several districts referred to above, even the partial inspection which has been made shows the existence of several serious evils in this community; prominent among them is that of overcrowded dwellings. Happily this evil has not yet attained the proportions in Baltimore which it has reached in other cities, but, from the following instances, it will readily be perceived that a foundation, at least, for the tenement-house system has already been laid in our midst. No. 73 Lancaster street is reported as being occupied by five families of 19 persons; No. 75, same street, contains five families of 18 persons; No. 100 Thames street, only 28 by 60 feet, with lot 28 by 30 feet, is occupied by five families of 34 persons; No. 128 Thames street contains three families of 16 persons; No. 263 Ann street, house 20 by 60 feet, has six families of 24 persons; No. 269 Ann street, house 18 by 70 feet, has six families of 37 persons; No. 290, same street, has five families of 18 persons.

Quite a number of other instances of overcrowding were noticed, and it seems probable that a thorough inspection of the whole city would reveal many more. The importance of securing comfortable and commodious accommodations for our laboring classes can scarcely be overestimated, but after the tenement system has once been fastened upon a large community, it is not an easy matter to sweep it away. Where it already exists to a large extent, as in New York, it can only be gotten rid of by long and patient effort; but there would seem to be no good reason why, in the case of a city like Baltimore, where the evil is still in its incipiency, it should not be forestalled by the efforts of an enlightened public spirit and philanthropy. Such an evil is as appalling in its moral as in its physical aspects. There is a fixed relation between comfort and morality. The man who comes home tired and exhausted wants quiet and comfort; if he finds filth, squalor, and discomfort in every shape around him, he naturally gets away from them and seeks selfish gratifications in the beer-shop, the brothel, or wherever they may be found. Virtue and vice are as dependent upon physical conditions as health and disease. "In these wretched dwellings," writes John Kay, of the tenement houses of London, "all ages and sexes—fathers and daughters, mothers and sons, grown up brothers and sisters, stranger adults—males and females—and swarms of children; the sick, the dying, and the dead are huddled together with a proximity and mutual pressure which brutes would resist; where it is physically impossible to preserve the ordinary decencies of life, where all sense of propriety and self-respect must be lost, to be replaced only by a recklessness of demeanor which necessarily results from vitiated minds."

Conceive the morality of those who are "cribbed, cabined, and confined," all the grades of low humanity together, as occurs in some of the dwellings on Thames, Lancaster, and Ann streets, in Baltimore. In one small house, with a superficial area of only 18 by 70 feet, thirty-seven men, women, and children are huddled together in misery and squalor! Under such circumstances, health not less than virtue is impossible. What says George Godwin, a philanthropist who has seen as much of the horrors of town shadows as most men? "Again and again would we assert that as you lead men and women to appreciate cleanliness, light, air, and order, you make them better citizens, increase their self-respect, and elevate them in the social scale. By the miserable dwellings to which thousands in our great cities are condemned, we are impelling them downward—an easy process—with frightful results. *It cannot be too often repeated that the health and morals of the people are regulated by their dwellings.*"

THE COST OF SICKNESS AND DEATH.

It is no very difficult thing to prove that every death caused by the want of proper social measures must be a loss to the community, and that all unnecessary sickness, requiring the expenditure of money to cure it, must also be a loss; pauperism, we know, is often increased by the untimely death of those who support families, and, as a consequence, there is an increased expenditure of the public money. It is not because there is a difficulty in proving these truths that their influence has been so little marked, but it is because men have so rarely thought of them. Let it be remembered that a sickly population is one of the most costly burdens of a state. "Health is the poor man's capital in trade, and whatever deteriorates that entails a direct loss and eventually a heavy money charge upon the community." The enormous amount of poverty in this country, as in most of the European countries, and the consequent necessity of expending millions of dollars annually for its relief, are in a great measure due to the pauperizing effects of preventable diseases. It has been stated that the money lost through yellow fever alone, by the city of New Orleans, during the epidemic of 1878, was nearly $20,000,000. To this add the loss sustained by other communities from the same epidemic, estimated at $175,000,000, and say whether the amount is not worth trying to save.

NEGLECT OF SANITARY LAWS.

A glance at the condition of affairs in the several districts inspected shows an alarming degree of indifference or negligence in the observance of sanitary laws in the city of Baltimore; and especially would this seem to be the case with reference to the emptying and purifying of privies. In the older parts of the city the primitive privy is almost universally used, and only in a few instances are they self-draining; they are generally simply a shallow pit from 4 to 6 feet in depth, which, in many instances, has to serve the purposes of from 10 to 20 persons. A moderate regard for health and cleanliness would suggest the emptying of these places at least three times a year, but as a general rule they are emptied only once or twice annually. The result, as already shown, is that they very often overflow, saturating the surrounding ground with their disease-breeding contents, and probably sowing the seeds of some terrible epidemic. The danger involved in this state of things is heightened by the fact that these privies have, in many cases, been in use for many years, and the earth around and beneath them has become so saturated with their foul contents that it no longer has any power or virtue as a deodorizing or disinfecting agent. They can, therefore, only be regarded as store-houses of disease, and the sooner they are superseded by an enlightened system of sewerage the better it will be for the future health of the city.

PROVISIONS OF THE CITY CODE.

The Baltimore City Code, article 23, section 79, provides that "all privies that are liable or likely to get into a state of nuisance between the 1st day of June and the 1st day of October shall be well cleaned between the 1st day of October and the 1st day of June, and it shall be the duty of the board of health to cause to be made, through the commissioners of police and the force under them, between the 1st and 10th of each June, a thorough inspection of all privies, wells, or vaults within the city, and all that then may be found to be full, or within 18 inches therefrom, shall be deemed in a state of nuisance, and the owner or owners, agent or agents of the

ordinary storms; notably in 1868, when 20 million cubic feet of water occupied the streets and residences of this densely populated section. From the margin of the "flooded district" the ground rises rapidly upon each side, reaching an elevation of 100 feet in a quarter of a mile on the west, and of 60 feet in the same distance on the east. Above this, along the whole course of the stream, the banks rise abruptly on each side.

On the north side of the harbor, lying between it and the Philadelphia Railroad, is an area of about 125 acres, the elevation of which is less than 6 feet above tide. It embraces the "City Dock," a pool 300 feet wide and 1,800 feet long, into which Jones's Falls has been conducted. It also receives Harford Run, the next largest stream which passes through the city. In dry weather, both these streams, which have been converted by bad management into open sewers, are intensely charged with effete products of the population; and for which the Dock acts as a catch-basin. This area embraces "District No. 1," already described in the first part of this report, and generally known as the typho-malarial district. As already stated, many of the residents in this district depend upon pumps in the neighborhood for their water supply, and cases of overcrowding in very old buildings have also been noted. The extent of the latter evil, heretofore commented upon, is thus described in the Sunday News, of June 20, 1880:

"The people, of what is called by some the malarial district, are becoming more and more alarmed at the overcrowding of some of the old houses in southeast Baltimore by impoverished emigrants, the majority of whom are Bohemians. On Aliceanna street, between Wolf and Ann streets, is an old building (the square is known as Bohemian Row), which has a front of 30 and a depth of 100 feet, and is two stories in height. It was about half a century ago used as a private dwelling. It has now been cut up into twenty small compartments, into which, at present, no less than sixty-eight human beings—men, women, and children—are indiscriminately huddled. The sight of the barefooted women, the ragged men, and half-naked children attracts the attention of all passers. This week two children died in this hive, and others are sick. The stench from the place is sickening in the extreme, and the only fresh air the inmates enjoy is that which they get by crowding out in the side yard, as they are ashamed to appear on the street in their half-nakedness or ragged habiliments."

On the western boundary of the city, at the head of the other prong, is a cove of nearly 100 acres in extent, into which Gwynn's Falls discharges. The sediment from this stream has nearly filled up the cove and converted the greater part of it into a marsh, leaving the remainder covered by a shallow stratum of stagnant water, bordered next to the city with a strip of low ground in a high state of cultivation. In this direction the ground immediately rises to an elevation of 16 feet along the line of the Baltimore and Ohio Railroad, and reaches 60 feet at Mount Clare, a half mile to the northwest, and gradually rises to an elevation of 230 feet in the extreme northwestern section of the city. On the opposite side the ground rises rapidly from the marsh; and below the cove the shore of the estuary continues with high ground and deep water throughout. Towards the north the course of Gwynn's Falls and its branches lies between steep hills. With the exception of the low areas just described, the ground rises every where with sufficient rapidity for the most perfect drainage.

GEOLOGICAL FORMATION.

With the exception of a ledge of gniess rock, which intrudes over a small area on each side of Jones's Falls, near the northern city limit, the whole of Baltimore stands upon a deposit of clay, sand, and gravel, sometimes alternating with each other, but with the coarser materials predominating at the base. Over a large extent, and on the highest elevations, a thick stratum of clean sand lies near the surface; while some of the lower outlying portions have at the surface a stratum of pure clay, the same which furnishes the famous Baltimore brick. At the base of all is a stratum of water-flowing gravel. This gravel is met with every where below the bed of Jones's Falls and at the bottom of the harbor along the water front. Beneath this is a thick and continuous stratum of tough, impervious clay, extending under the harbor, which the well diggers designate as the "river bottom."

DRAINAGE.

In the western section of the city a stream called Schröder's Run originates at an elevation of 160 feet, in the neighborhood of the Cathedral Cemetery, and flowing southwest for two miles enters "Ridgley's Cove," just east of the marshy cove above described. Opposite to this, and draining from the same neighborhood, another stream, three-quarters of a mile long, discharges into Jones's Falls at the northern corporate line of the city.

At a half mile towards the east, and upon ground of the same elevation as the former, in the neighborhood of Eutaw Place, a stream called Chatsworth Run gathers the drainage, and flowing in the same direction for a mile and three-quarters, joins Schröder's Run just before reaching Ridgley's Cove. Draining from the same area in the opposite direction a stream a half mile long discharges into Jones's Falls nearly a half mile below the former one on this side.

Two other streams originate, at an elevation of 100 feet, in the neighborhood of the present Johns Hopkins University buildings; one, taking the course of Tyson, Liberty, and Howard streets, flows down upon the neck, where commences the peninsula of South Baltimore, and across which it has been conducted by a sewer along South Howard street and discharged into Ridgley's Cove, near the entrance of Schröder's Run. Its counterpart flows due east along Centre street, and discharges into Jones's Falls at the upper end of the "flooded district."

Another small stream gathers on Federal Hill, in South Baltimore, at an elevation of 75 feet, and flowing southwest for nearly a half mile discharges into Ridgley's Cove near the Howard-street sewer.

All these streams originate in and flow through fully-occupied sections of the city, and they are, in part, conducted through sewers of an irregular character. The two largest, Schröder's Run and Chatsworth Run, before reaching Ridgley's Cove flow in their ancient and natural beds for nearly a mile, and during warm, dry weather the water which they contain is usually black and reeking with noxious gases. The unoccupied portions of the western section of the city drain into a stream called Little Gwynn's Falls, which gathers in the neighborhood of Hookstown, a suburban village, two and a half miles northwest of the city limits, and enters Gwynn's Falls proper a mile above the cove. This is an exceedingly filthy stream.

In the Eastern Section (*i. e.* east of Jones's Falls), the first stream within the present corporate limits is "Jenkins's Run," which originates at the northern limits of the village of Waverly, more than a mile from the city, at an elevation of 200 feet, after draining, with several branches, a thickly populated suburban district, in which are many slaughter houses, distilleries, hair factories, tanneries, and other foul establishments, it passes for a half mile through the city and discharges into Jones's Falls near the western portal of the tunnel of the Union railroad, where that road joins with the Northern Central Railroad. Within the city it passes through a sewer 12 by 18 feet diameter at the upper end, which sewer is reduced at the lower end, before it enters Jones's Falls, to a diameter of 7 by 7 feet.

The next drain is a small stream which gathers on Gallows Hill at an elevation of 120 feet, and flows through a sewer along McKim and Monument streets to Jones's Falls, where it discharges.

HARFORD RUN.

The third stream is Harford Run, which drains from "Clifton," the future site of the Johns Hopkins University, at an elevation of 200 feet, and a half mile beyond the city limits. After crossing the Union Railroad at Belair avenue it passes through a series of irregular sewers and drains, through yards, and under houses, to Central avenue, along which it is conducted by a regular sewer to the city dock. This irregular part of the sewerage of Harford Run nearly describes a circular arc, of which the Johns Hopkins Hospital, standing at an elevation of 110 feet and a quarter of a mile distant to the east, is the center. From the city limits to the Dock the course of this stream is two and three-quarter miles. Its filthy condition has been a subject of public criticism for many years past, and the evil finally became so intolerable that the city council was induced last year to make an appropriation to improve the condition of the stream by changing its course and arching it throughout. The work is now in progress, but as it is not laid out in conformity with any plan for the future sewerage of the city, we may well believe that, except for temporary purposes, it will be a fruitless expenditure of money. In referring to this matter the Baltimore American of the 23d of July, 1880, thus forcibly speaks:

"Sooner or later Baltimore must have a thorough system of underground sewerage and drainage. The trouble, losses, and suffering that have been occasioned in the northeastern section by the overflowing of Harford Run by an ordinary summer rainfall, emphasize the necessity of a comprehensive and systematic plan. Scores of families of poor people have had their homes undermined, their furniture injured, and the daily occupations upon which they depend for their bread and meat interrupted, because the municipal government has for twenty years been trifling with the nuisance of a slow-moving stream of filth, and has just resolved to endure it no longer. If the Harford Run sewer is not constructed with more engineering skill than was displayed in that on Liberty street, a great deal of money will again be expended without producing the proper results. The beginning of it proved on Tuesday a remarkably efficient aid in backing water into all the cellars in the neighborhood."

Another stream, called "Harris's Creek," drains from the neighborhood of the Baltimore Cemetery at an elevation of 175 feet, and flows south along the eastern outskirts of the city, where there have recently been erected blocks of new and clean residences. This stream enters the harbor immediately opposite Locust Point, the marine terminus of the Baltimore and Ohio Railroad, having had a course of two miles. The lower end of the stream, for nearly a half mile, formed a tidal inlet three or four hundred feet wide; but it has been nearly filled up with oyster shells from the packing establishments, and waste products of factories, furnaces, and residences. East of Harris's Creek at this point the ground rises immediately, and reaches an elevation of 125 feet at Highlandtown, a half mile distant. The lands of the Canton Company continue in this direction far beyond the city limits, preserving to the water's edge the most favorable conditions for drainage.

hydrogen and other noxious gases, and gives a dark hue to white paint.

It frequently happens that immense numbers of fish enter the basin when the water is in a state of comparative purity and remain there until Jones's Falls, the great generator of the foul and poisonous water, accumulates it in their rear, cutting off their retreat, and then the water in the entire basin gradually assumes the same condition, until it will no longer support animal life. On such occasions the fish are seen floating in thousands on the surface and loading the atmosphere with another noisome odor. It is well known that the pollution of the basin has been at times greatly increased by a violation of the law forbidding the emptying of night-soil into its waters by those engaged in cleaning privy-vaults. In the past few years this practice has been somewhat checked.

Dredging machines are now constantly employed in removing the black mud and slime which is always accumulating in the docks and along the pool of Jones's Falls. These foul sediments have been deposited at various points near the shore several miles below, where they have created similar nuisances in the neighborhood, and for which fines have been imposed upon the contractors by the legal authorities of Baltimore County. In one instance damages were awarded to the extent of $10,000.

In 1859 a commission appointed by the mayor and city council and headed by Henry Tyson, civil engineer, reported a plan for a system of sewers to be located along the principal depressions and designed to carry the surface drainage to the nearest tide-water, in which occurs the following paragraph relating to the pollution of the basin: "In most European and American cities, the water-closets are allowed to discharge into the sewers. This plan, we think, may be advisable in cities located on the sea-coast, the harbors of which are swept by the tide, or upon the banks of large rivers with strong currents. To pursue this system with the city of Baltimore would turn its land locked harbor (the basin) into a vast cess-pool and materially affect the health of the city during the summer months. The Thames at London has become so polluted with the increased size of the city that the English Government has now under consideration the propriety of conveying off the drainage to the sea, near the mouth of that river, by immense conduits. The plan for the accomplishment of this object by Messrs. Bazalgette & Haywood, it is estimated, will cost £3,000,000."* This report seems not to have recognized the fact that the basin was already a "cess-pool," and it ignored the fact that many thousand self-draining wells were then discharging into it.

In 1871, Engineers Craighill and Kneass, employed by another commission, reported a plan for the improvement of Jones's Falls, principally with a view of preventing overflow. In referring to the basin they make the following suggestions: "A good method of correcting to a great extent the filthiness of the basin is, to arrange near the outlet of each sewer a receptacle where the most corrupting elements may be caught, purified, and removed. Private sewers, emptying into the basin should be strictly prohibited. The great sewers, after receiving the contents of the smaller, should be few in number when they reach the basin. It will be neither difficult nor expensive to prepare for each of these large sewers, in the dock in which its mouth shall be located, such a receptacle as has been referred to above, where the more solid matters may be collected and removed at suitable intervals." This report also ignores the existence of the subterranean flow from the bottom of the deep wells, and assumes that everything not solid or no heavier than the water in which it is finely suspended, may be allowed to escape into the basin with no evil consequence.

In 1873, Mr. Wm. J. McAlpine, civil engineer, employed by a commission appointed to devise means for purifying the basin, submitted a report in which the following occurs: "The substances causing these noxious exhalations are brought into the basin—first, by the present sewers; second, by superficial street drains; third, by garbage thrown into the basin; fourth, by the flood tides, which carry the foregoing matters forward and deposit them in the basin." Mr. McAlpine, like the other engineers, has also ignored the effect of the self-draining wells in polluting the waters of the basin.

In February, 1876, Mayor Latrobe sent to the city council a special message in relation to the basin nuisance, in which he says:

"Summer after summer our city is assailed during the heated term with a most abominable stench, arising from what is now the receptacle of the filth of a great and rapidly growing city, emptied into it by our present system of surface and sewer drainage. With each succeeding year during this noxious period, the people cry aloud against a continuance of an evil that actually threatens the necessity of an abandonment of the immediate neighborhood of this 'pool,' or the lives of the whole community by aiding any migratory pestilence that might visit the city. This nuisance should certainly be abated, and whatever reasonable cost might be incurred would, if honestly and economically expended, be cheerfully met by the people.

Either the smell of the basin must be cured, or the city of Baltimore will be driven from its shores. There is no other community that would, in the present age of refinement and high civilization, so long endure such a curable evil."

* This plan has since been carried into execution, and the actual cost was [illegible].

Mayor Latrobe, under date of September 11, 1876, in another message, to the city council, takes occasion to remind that body again of the basin nuisance, and suggests the remedy of an intercepting sewer. His language is as follows:

"For many years past the city of Baltimore has used the basin as the common receptacle of all its sewage, notwithstanding the fact that summer after summer we were reminded by its disagreeable odor that this nuisance should be abated.

* * * * * * *

"It is certainly manifest that, independently altogether of the sugar refineries, if the city continues to annually discharge its constantly increasing drainage of filth and sewage into the almost tideless waters of the basin without constantly dredging it out again, the water must necessarily become polluted, and exhale noxious and offensive odors, constantly threatening the health of our citizens.

"Under these circumstances it becomes a matter for consideration whether the certain cure of any recurrence of that well-remembered 'stench,' without interference with our manufacturing or commercial interests, would not be the construction of the intercepting sewer recommended by the committee appointed by the city council in 1873, and provided for by the enabling act of the last session of the general assembly. If this is the remedy—and I believe that it is—it becomes a question for your honorable body to consider whether this is not a most favorable time for the commencement and prosecution of the work."

Again, in his annual message to the city council, January 1, 1879, Mayor Latrobe uses the following language in reference to the basin:

"During the winter months we are so free from the basin nuisance that, forgetting its offensive summer odors, we are led to believe that perhaps the basin at last has cured itself. The permanent abatement of the basin nuisance is, however, a subject to which the attention of the council should be earnestly directed. Many plans have been suggested, and public opinion seems to be divided upon the subject. For my own part, I have always believed in the necessity of preventing the basin from being made the receptacle of the filthy sewerage of the city, by the construction of an intercepting sewer, as is being done in Boston, with which the sewers already constructed, and those required hereafter, could be connected. Such a sewer would receive and carry off to some point on the river, where it would be swept away with the tide, all deleterious matter discharged from soap factories, sugar refineries, gutter drainage, &c., &c., that now finds its way into the basin. There are others, however, who think the nuisance would be better abated by the adoption of a plan for flushing the basin with pure water, and thus cleansing it by dilution. The subject is one of importance, and the public will never be satisfied until the different plans have been submitted to scientific investigation. For this reason I suggest that power be given to the mayor to appoint a proper commission of three gentlemen with the requisite knowledge on such subjects, who shall make an investigation into the cause of the basin nuisance and suggest a plan for its cure. The expense attending such an investigation would be small, and the report would doubtless enable the city council to estimate the cost of what at no very distant day must be undertaken by the city."

We thus see that there is an accumulation of authority for saying that the basin, under existing circumstances, is a foul, disease-engendering cess pool, and that the abatement of the nuisance is essential from every point of view. The whole question is manifestly one of difficulty, but it is one which deeply concerns all classes of the community. No class possesses an immunity from the evils which the neglect of the laws of sanitation bring into existence: all are subject to their influence. Hence the importance of the municipal authorities taking boldly hold of this question. The safety of the people should be the supreme law!

The plan of an intercepting sewer along the water front to connect with the present sewers, as well as those which may be constructed in the future, and conduct their flow to some point below the harbor, is undoubtedly the first and most important step towards abating this great nuisance, provided it is so constructed as to intercept the unperceived flow which now issues from the many thousand self-draining privies, through the gravelly base of the city, at every point along Jones's Falls, as well as the whole water front.

Many intelligent citizens of Baltimore have, apparently, satisfied themselves that the odors, or, as Mayor Latrobe aptly terms it, "the stench" of Jones's Falls and the basin are almost entirely due to the operation of refining sugar, with the discharge of the waste products into these receptacles. But it is an unquestionable fact that the existence of the stench preceded the establishment of the refineries, and has continued to a large extent since the abatement of the alleged nuisance. Thus, in February, 1853, Capt. Montgomery C. Meigs, U. S. Engineers, now Quartermaster-General of the United States Army, who was consulted, thus expressed his views in reference to an additional water-supply: "Every reason which would induce me to recommend a liberal supply of water for Washington applies with equal force to Baltimore, which, moreover, needs a larger quantity of water to purify the stagnant harbor, *whose odors during the last summer must be in the recollection of all its inhabitants, as they are with that of all who passed through the city by railroad.*" At this period the Calvert refinery, which is charged with all the evil, was not built, and the business of refining sugar in Baltimore was just

substratum of the city into the harbor. They have their pure sources in the elevated regions at a distance; they follow fissures in the rocks, and strata more or less isolated from the general formation under the city, and enter it with a pure volume, and subsequently commingle with the polluting product of the city in the wells. They are, therefore, although contaminated, pure compared to that which flows from the privy wells into the subjacent soil, and finally into the harbor.

If a total suppression of the privy-well system should be determined upon in favor of a general system of sewerage, which the city so much needs, a question would arise as to the most efficacious and economical method of carrying out this measure. If the sewers are constructed with a view, not only of performing a sanitary office, but at the same time to receive and conduct the volumes of water which fall upon the suface during storms, it will necessitate adequate dimensions, and which are vastly in excess of what the first duty would require. These excessive dimensions would be imposed upon tubes which must be maintained in accurate form and position, of smooth and regular interior, water-tight throughout, and secure from all liability to fracture, obstruction, and escapement, increasing to a corresponding extent the cost of securing these features. They must also be provided with special cleaning, trapping, and ventilating arrangements on the same scale—features, in part, unnecessary for the second duty alone.

The *débris* with which the public streets are always strewn—sticks, stones, bricks, and every variety of trash—will be constantly swept into these sewers by a sudden torrent of rain, causing obstructions troublesome to remove and frequently choking them to the extent of forcing their promiscuous contents into the streets and cellars. They arrest within their numerous traps deposits of the foulest nature, requiring the most awkward and offensive operations for their removal. The traps for intercepting gases are more apparent than real. The small body of water interposed absorbs the gases on one side and exhales them on the other, a process which increases with the pressure within the sewers; while most frequently the obstruction interposed by the trap only determines the escape of the gases into sleeping apartments instead of the open air of the streets.

A sufficient and uniform supply of water is absolutely essential to the proper operation of a sanitary sewerage; but the sewers, which are designed to be assisted in their action by the surface drainage of the streets, find such assistance to fail them totally, at the very period when it is most needed, that of heat and drought, or else they are disrupted or choked, and their contents diverted by a deluge of rain succeeding the drought. Most frequently the assistance of the rain is either absent, unnecessary, or in injurious excess.

To provide for the passage of storm-water requires, not only the extra expense of the large scale upon which such nice and particular work as required for sanitary sewerage must be executed, but it requires conditions, due to the size of the vent, least favorable to the flow of the limited and uniform volume which alone can be relied upon. Instead of having a channel with the least surface in contact with the fluid, which is the measure of the resistance to the flow, this becomes the flat arc of a large circle, presenting a much greater surface of contact to the same volume. Where the inclination of these sewers is slight, a greater depth of water is acquired by accumulation, with consequent stagnation and putrefaction; where the inclination is rapid, floating solids become stranded along the sides and bottom with still worse effect.

A consideration which has influenced the adoption of the combination system is the advantage of having the beds of the streets to coincide with each other where they intersect, and thus avoid the interruption caused by the gutters of one street extending across the middle of the other, which occasions either an annoying check in the speed, a disagreeable jolt, or a complete stalling. This is obviated when the streets are provided with sewers. The gutters then terminate at an inlet instead of crossing the other street, which enables the middle of both to coincide in a common plane.

This system requires such an extent of sewers for surface drainage that it is combined with the other as a measure of economy and justification. The evil effect of it is illustrated in the sewerage of several American cities, notably the city of Washington, whose streets have been graded and paved with special reference to the driving of elegant equipages and vehicles of pleasure. Here every inlet informs the passer-by of the existence of a stagnant cess-pool beneath the street, or of the incomplete transportation of matters assigned to an insufficient volume.

In the city of Baltimore this gutter interruption is, in many places, remedied by bridging them over with plates of cast iron, corrugated upon the upper surface, which yields a most disagreeable noise to every passing wheel. At every heavy rain th eybecome choked with the trash and garbage washed down from streets and alleys, creating an overflow above them, and leaving a deposit of putrescible matters beneath them.

In many of those streets coinciding with the natural depressions on the surface of the ground, the water accumulates during heavy rains to such an extent as to become a formidable obstruction to pedestrians, and frequently invades the sidewalks and cellars. During severe freezing weather, with the ordinary drainage, large accumulations of ice occur, which have to be removed from time to time to enable vehicles to pass. At some of these places stepping-stones have been provided at others a complete remedy has been effected by sewers below the surface to carry off the storm-water. In these instances a sewer for the surface drainage, leading to the nearest available outlet, no city should forego; but much the largest proportion of the streets have only to drain the territory in their immediate vicinity, and but for the constant small stream of impure water discharged from the houses would need no gutters, for there could be no objection to the storm-water flowing in a uniform sheet over the entire breadth of the street over the curb-stones of the sidewalk, as its duration would be short, and concur with the absence of pedestrains from the streets. If the streets were so graded as to form a regular plane, instead of a convex surface, and thus constitute one broad gutter with a flat bottom, and bounded with the curb of the sidewalk on either side, there would be no interruption at their crossings, and the surface drainage would be perfect.

So long as it is permitted to discharge impure waters upon the streets, it will be a necessity to concentrate them into gutters; but if the law compelled all such fluids to flow into sewers, with which every house necessarily formed a junction, and allowed only the pure water of the private hose, the street sprinkler, and the storm and showers to flow upon the streets, the gutters over the largest area might be dispensed with, and one crying nuisance abolished.

In every well governed city the dirt which must necessarily accumulate in the streets is regularly swept up and carried off; and where the streets are properly graded and paved this operation is an inexpensive one and can be rapidly and economically performed by machines. In some cities the value of the product is more than the expense of removing it. In Baltimore, where the streets are in the most primitive condition, this process is an expensive and tedious one, and consequently is resorted to at long intervals, during which the dirt becomes the sport of the winds, and, in the summer time particularly, is distributed through the dwellings. But whether this sweeping is sufficient or not, there can be no very great evil in allowing the washings of the streets during falls of rain to flow directly into the harbor. Its character and quantity is such that it does not readily undergo offensive decomposition, and its removal thus is always accompanied with that great preventive, a copious supply of fresh water; but this cannot be said of those innumerable and perpetual streams of composite fluid which now flow in all the gutters, either lawfully or they are too widely distributed and too difficult to trace to be prevented by the police. That which finally reaches the harbor must contribute its full share to its pollution, unless it has exhausted its effect upon the atmosphere of the city during its slow journey. The greater part is absorbed by the sandy soil upon which the gutters and pavements are laid, passing through the spaces between the bowlders and spreading through the heated soil near the surface. The proper disposition of all such fluids is unquestionably the sewer of sanitation.

If the well-system is abolished—which a proper regard for the future health of the community demands—and the surface drainage continued, with sewers only in the principal depressions, and they restricted only to storm-water, then a system of special sewerage, devoted exclusively to sanitation, must be adopted. In this we have to deal with a subject whose conditions are constant and uniform, and within the range of easy calculation. This highly important operation will admit of the application of the most scientific and skillful devices in the smallest proportions necessary for one office, and enable the sanitary engineer to accomplish his object with certainty and economy. And if any apparatus or process should hereafter be invented by which the barren and impoverished soils which cover so large a territory in the neighborhood of the city may be profitably restored to a healthful and attractive fertility as the result of such operations, the special system of sewerage will be the best calculated for their application. The sewer for receiving the storm-water, though important, should be postponed to that which is a necessity. It has become imperative to lessen the nuisance occasioned by the present system of privy vaults, as well as that occasioned by the drainage from kitchens and sculleries and overflowing slop-tubs and garbage receptacles, and that resulting from the pursuit of many industries, all of which now join in the general chorus of the gutter rill. The following from the Baltimore Sun of August 5, 1880, is pertinent to the subject:

"SEWERS, SEWAGE, AND SEWAGE FARMS.—Before long the city council of Baltimore may be called upon to consider the question of sewerage. Dr. Billings, an excellent authority, has expressed his opinion that a system of sewers is essential to the health of the city. So also declare the State board of health and our local board of health commissioners. What is meant by 'a system of sewers' we have yet to learn. An intercepting sewer, constructed on the plan of the Hambleton survey, to catch and carry off the drainage that now finds its way to the inner harbor, only to be dredged out again at a large annual expense, is undoubtedly desirable, provided sufficient fall can be given to it to take the sewage far enough down the river, either to be utilized on what are called 'sewage farms,' or if discharged into the river itself to prevent its return by the inflowing tide. The plan of sewerage recently adopted in Memphis and other cities may possibly be found suitable to Baltimore. It consists in the use of pipes to carry off the house sewage only, leaving storm-water to be carried away by surface drainage. Such a plan, with the surface drainage and also the smaller network of sewers discharging into the

main intercepting sewers, might be carried out at a not unreasonable cost considering the sanitary benefit to be derived from it, and the trouble and expense and continual harassment to which the city is subjected in finding unobjectionable dumping grounds. Philadelphia is at this time experiencing a similar trouble, not only from the poisoning of the soil by the liquids from privy-wells, of which it is estimated that nearly five hundred thousand persons make use, but also from the fact that 'the sewage of two hundred and ninety thousand persons daily reaches the rivers, which, after a long drought, are likely to be polluted.' But underlying these facts is the important question as to what shall be done with all this sewage. Experience thus far favors its use by distributing it among sewage farms. In Massachusetts this distribution of the sewage on a small scale has been attended with marked success. There the experiment has been tried at the Danvers and Worcester Asylums. At the latter the sewage farm is distant half a mile from the building, and the sewage is carried to it through simple trenches and distributed at the rate of three thousand gallons per acre. At the Danvers Asylum the sewage is carried about the land near to the house by means of simple wooden troughs, and it is said that 'with a little intelligent care all offensive odors are avoided.' In both instances much larger crops are raised than ever before. At Lenox the subirrigation plan of the famous English agriculturist, Mr. Mechi, has been adopted, the sewage being distributed through a series of ordinary tile drains about a foot below the surface of the ground. In England this mode of distributing sewage has been extensively used, and the plan has been fostered by the annual prizes which the Royal Agricultural Society offers for the best sewage farms, including similar farms in Ireland and Scotland. There are about one hundred of these sewage farms in operation in Great Britain. According to the report recently published, and as might have been expected, it has been found that the great market gardens within easy distance of large cities return the most profit from the use of sewage. One other important conclusion is reached by the committee. It is in respect to the sanitary effects of sewage on the hands employed on sewage farms. It was found that 'among the persons either living or working on the farms the average rate of mortality did not exceed three per thousand per annum,' which is 'not more,' it is said, 'than an equal number of selected lives taken from an agricultural district.' What the effect of sewage on the health of field hands would be in our hotter climate is yet to be determined."

The sanitary condition of Baltimore is a subject worthy the consideration of both the municipal, State, and national health authorities. That the existing evils are dangerous *per se* there is no evidence to affirm; but how far they may be capable of developing any of the diseases which need some germ or some special chemical or physical cause for their initiation is a subject upon which science throws a feeble but sinister light. The combined labors of those who pursue chemistry, biology, medicine, and physics are required to guide the sanitary engineer in any measures except those which are dictated by the instinct of man and even animals, to seek pure air and water, to hide, avoid, and banish every element rejected in the organic process of life, or capable of contaminating the atmosphere.

The ever-growing necessities of an increasing population should be met by a corresponding activity of the mind and will. But a large portion of the inhabitants of our large cities find themselves powerless to obey those instincts which nature seems to have provided to indicate the true sources of health. They find themselves imprisoned in close quarters with thousands of their fellows, in an atmosphere saturated with foul vapors, without the means of securing sufficient or appropriate food or even pure water, and without protection from the extremes of heat, cold, and dampness. It is for the more fortunate, intelligent, and thoughtful members of the community, who witness these arsenals of disease gathering the elements of avenging epidemics, to aid with their influence in inaugurating a thorough and systematic plan of sanitation, and to take the first steps in a series which shall finally complete it.

Epidemics need only those unknown but sufficient causes to kindle a flame which may include in its devastations the most salubrious as well as the most filthy districts; and the sordid man who locks up his pocket and votes against a tax to prevent or correct such evils cannot guard his own spacious and luxurious abode against the malady his own avarice has helped to originate. *"Pallida mors æquo pulsat pede pauperum tabernas regumque turres."*

Respectfully submitted.

C. W. CHANCELLOR, *M. D*

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REPORT OF AN INVESTIGATION TO DETERMINE THE PREVALENCE OF ADULTERATION IN FOOD SUPPLIES, UNDERTAKEN IN ACCORDANCE WITH INSTRUCTIONS FROM THE NATIONAL BOARD OF HEALTH.

[BY DR. CHARLES SMART, U. S. A.]

To institute a thorough examination into the prevalence of food adulteration would occupy a much longer time than has been accorded the writer for this investigation. The number of articles which enter into the food supply is so great that many of them had of necessity to be omitted. Hence, milk, butter, wines and liquors, preserves and canned goods, &c., do not appear on the following record. The articles which were first presented for examination were accepted, and work having been commenced upon them it was continued, sample after sample, until a sufficient number of specimens had been examined to enable a general statement to be made concerning their condition. Nevertheless it is believed that the investigation, limited as it has been, will be found to have fulfilled its intention definitely.

Some difficulty was experienced in obtaining the samples. A circular was issued to State and municipal health boards requesting their co-operation, but the number of specimens gathered by this means was very small. In the mean time, through the kindness of Dr. Smith Townshend, health officer of this city, many samples of various articles were procured from first-class stores. These were accepted and investigated as illustrative of the character of what might be expected to be pure goods. The dealers who voluntarily furnished them were aware of the object intended in making the collection, and it is hardly to be supposed that any of them would have knowingly sent in an adulterated article. If these specimens had proved to be all pure and unadulterated the results would have had no bearing in connection with this report, but if, as proved to be the case, samples of adulterated goods occurred among them, each such sample would have a greater value as bearing on the prevalence of adulteration than if it had been bought at a store where adulteration, if prevalent, might be expected to be found.

A number of the specimens examined were due to the courtesy of the Commissary-General of Subsistence of the Army. These consisted chiefly of flours brought in from military posts and depots in different parts of the country, and of pepper, ground spices, and baking-powders in cans procured from manufacturers and wholesale dealers. As these samples were liable to be examined by inspectors and Army boards the presumption in favor of their purity was nearly as strong as in the case of the specimens sent in by the dealers of this city; and correspondingly an adulterated article occurring among them would have a larger meaning than if it had been bought in some of the low-class stores of this or any other city.

Failing a response from the health boards addressed by circular as aforesaid, permission was obtained to make purchases in the poorer districts of this city; but as the appropriation for this purpose was small an effort was made to economize it by buying only the smallest purchasable quantity of each article. This led to difficulty in obtaining specimens. The dealer had a curiosity to know why such purchases were made, and becoming suspicious from the hesitation of the messenger, immediately refused to furnish the articles. The writer made several purchases in person and experienced this treatment—the previously courteous storekeepers becoming resentful and even aggressive when the object was purposely made known to them. This, when taken in connection with the subsequently-ascertained character of purchases in similar localities, leads to the supposition that the percentage of pure articles in this report has not been decreased by their refusal to sell.

A larger appropriation having been made by the executive committee, no further trouble was experienced and the necessary purchases were made in this city, in New York, and in Baltimore, Maryland.

This report therefore embraces the results of the examination of two series of samples, one of which was derived from sources whence purity might be expected, and the other from sources which might be presumed to yield low grade, if not adulterated, goods.

A great deal of sensational writing has appeared from time to time concerning food adulteration, the text of which has mainly been derived from English experience. Loose statements have been made even in official reports which have fostered the sensational outcry until it has reached such a pitch as to suggest the defeat of its object by creating a prejudice against itself. Compilations from Hassall's book have been published as personal experience, and quoted so often that the people have become tired of hearing about food adulteration, and discredit the whole thing, except perhaps that milk may sometimes be watered. Statements of individual facts are required to place the subject on a sound basis, and for this reason, while a general summary of results is presented as the body of this report, there is appended an itemized list of the facts developed during the investigation.

A careful comparison of the results with the facts developed during the investigation by the English committee twenty-five years ago shows clearly that food adulteration is practiced in this country at the present time to as great if not to a greater extent than prevailed in England at the time of the agitation which led to the enactment of repressive laws. Our corn-meal and lard are pure. Our wheat-flour is not mixed with alum, but the bakers use it. Our sugars are cleaner, but we have glucose admixtures which the English had not; and if our coffees are better, it is owing more to the practice of home grinding bequeathed to us from the early days of the country when grocery stores were not so common as they are now. The few samples of loose coffee which were found to be adulterated, show that there is a tendency to debase the article, which would no doubt increase as the coffee-mills disappear from our kitchens until the condition of the market would be represented by the trash which is now sold as package coffee. On the other hand, the remainder of the articles included in this report are found to be in as bad, and many of them, as the peppers, allspice, cinnamon, &c., in a worse condition, than were the English supplies when official attention was directed to them.

Fortunately, with such exceptions as the alum in bread and baking materials, the sulphate of lime which oftentimes replaces cream of tartar in household baking, the debasement of milk by dilution, and the poisonous pigments used for coloring confectionery, the adulterations cannot be considered as deleterious. They affect the pocket of the individual rather than his health, so that, to use the words of the committee appointed by the National Board of Trade to award prizes for the best draught of an act repressive of adulteration, "the question of adulteration of food should therefore be considered not so much from a sanitary standpoint as from that of commercial interests; as being of the nature of a fraud in aiding the sale of articles which are not what they are represented to be."

Seven hundred and thirteen samples were examined. Of these 304 were obtained from sources which implied purity, as already explained, and 409 from those which might be considered suspicious. Of the former 24 or 7.89 per cent. were found to be of such a character that under a law repressive of fraudulent adulteration prosecution might have been instituted with full prospect of effecting conviction. Of the latter 183 or 44.74 per cent. would have been in like manner condemned.

But these percentages, although they appear to give expression to the prevalence of adulteration, in reality convey no meaning. Lard and corn-meal were found to be unadulterated. If, instead of a few samples of these articles, enough to determine their general character, a large number had been included in the report, the percentages of impurity would have been proportionately diminished, but the facts would have remained the same. So, had the examinations of ground spices been multiplied, the percentages of impurity would have been increased. To appreciate the condition of things the facts relating to each article of supply must be considered separately.

TEA.

Those who desire to present a strong case concerning the prevalence of adulteration in food regard the facing on green tea as authorizing them in giving that article a place on their list of illustrations. Chinese teas are dusted with Prussian blue, and Japan teas with indigo along with finely pulverized sulphate of lime and silicates.

If these substances were suspected of being deleterious in the quantity present on the most coarsely-faced specimens, the green teas should undoubtedly be condemned. But there is no evidence to show the unwholesomeness of the facing. If the color hid the quality of the leaf so that a poor tea might be passed off as a superior article, some action might be warranted, but the color can be removed easily and the leaves judged by their natural appearance. Indeed the facing itself constitutes a criterion of quality, it being invariably fine

or coarse as the leaves are young and high-priced or old and cheap. Again, if the powder were used in such quantity as to be a substitute for a notable weight of the leaves, an objection to its use might be in place. But the facing seldom adds materially to the weight. Some of the greens which were examined contained less mineral matter than the unfaced black teas. The average ash of clean Oolongs, which are but slightly dusted, was found to be 6.29 per cent. of the dry tea, while that of similarly clean but regularly faced greens was 6.20 per cent. The sand and clay which black tea gathers during its fermentation is more than an offset to the pulverulent facing applied to the greens, as the minimum of ash in the Congous is 6.47 per cent. Lastly, green tea is purchased for importation with a full knowledge on the part of the purchaser concerning the existence of the facing. There is no deception or attempt at deception now, although the practice of coloring may have originated in an effort of this kind.

The English law until lately made the mistake of regarding the facing of tea as an adulteration. This law was grievously oppressive to retailers, many of whom were prosecuted and fined and their business and characters injured for selling tea in good faith in the same state in which it was imported from China, and on which the customs had received tea duty. The wholesale tea trade of London submitted a memorial to the chancellor of the exchequer suggesting that each chop or parcel of tea should be sampled and examined by sanitary inspectors before being admitted for home consumption, and that the prosecution of retailers be suspended until the food adulteration act should be amended in this respect. As a result of this memorial the ninth annual report of the local government board gives a summary of the work of the analyst of the commissioners of customs during the year 1879, from which the satisfactory character of the teas imported may be ascertained. Of 575 specimens only seventeen were of such a character as to require the board's directions as to their disposal, but as fourteen of these were allowed to be delivered without any restriction, there remained only three for special action, and only one of these, fresh-water damaged, was condemned to be destroyed, while one with old and exhausted leaves was allowed to be delivered for exportation only, and the third, plundered in China and the weight made up with sand, was sifted and repacked. The facing of the greens was light.

It is probable that if such a system of customs' inspection existed in this country our importations would be found to be in equally satisfactory condition. This is deduced from the fact that of eighty-eight teas which were presented by dealers for examination, and which represented all qualities, at prices ranging from 33 cents to $1.40 per pound, not one sample was found to be debased in any way. Some contained a larger amount of mineral matter than others, but in none did this exceed what might be allowed as incidental to the gathering, fermenting, drying, and other processes necessary to the preparation and preservation of the leaves. One sample contained a small piece of iron, probably accidentally present, as a careful search showed it to be the only fragment of the kind. Two specimens contained numbers of minute pebbles, about the size of a pinhead, and as these occurred among leaves of a quality on the preparation of which great care is usually expended, it is hardly possible to suppose their presence unknown to the individuals concerned in the preparation. In these cases the mineral addition was so small, 1 per cent., that but for the superior quality of the tea they might have been passed over as accidental.

The mixture of teas of different qualities or values is undoubtedly practiced by dealers in this country, as in England. Many of the samples showed leaves which were unmistakably of different parcels. But this appears to be a point with which legislation should have no concern. If the sample consists of tea leaves, or fragments of tea leaves which have not been debased by exhaustion or mineral addition, there is no imposition on the purchaser, no matter what price he pays for the article. Many old and low-priced teas yield as much theine, as much soluble salts, and as much extractive as younger and high-priced samples. The difference lies in the aroma, but this is a matter of luxury, not of food.

The teas examined numbered 117, but of these two which were grown in Georgia and six sent specially from Japan may be excluded from present consideration. Of the 109 remaining, 90 were obtained from sources which presumably should have furnished a pure article, while 19 were purchased at such stores as might be expected to furnish an adulterated article, if adulteration was at all prevalent. In no case was a leaf observed which was not a true tea leaf. Of the 90 the only cases of debasement were those already mentioned as having probably originated before importation, while five of the 19 were so deteriorated that an analyst would have been warranted in reporting them as fraudulently adulterated—one, gunpowder (Y 2), from an excess of lime sulphate facing; one, imperial (W 2), from admixture with sand, and three, imperials (Y 1, 2, and 3), from the presence of exhausted leaves. Whether these debasements were effected in China or in this country is an open question; but from the character of the English importations it is probable that exhausted leaves are dried and recolored in this country for sale among the poorer classes of the community.

The following represents the tea samples and the results of their examination according as they would have been approved or condemned by a public analyst, A indicating their derivation from a source where the presumption was in favor of purity, and Z from one where adulteration, if prevalent, might be expected to be found:

	A	Approved.	Condemned.	Z	Approved.	Condemned.
Congous	6	6	.....	2	2	.....
Pekoes	2	2	.....	.....	.....	.....
Oolongs	31	31	.....	4	4	.....
Gunpowders	29	29	.....	2	1	1
Imperials	12	12	.....	7	3	4
Hysons	7	7	.....	3	3	.....
Japans	11	11	.....	1	1	.....
Total	98	98	.....	19	14	5

COFFEE.

In England the chief adulterant of coffee is chicory. Dr. Hassall testified before the food commission, in 1855, that of 34 samples which he had examined 31 contained chicory. Normandy found as much as 75 per cent. of chicory. Besides the chicory evidence was given as to the occasional presence in coffee of roasted wheat and beans, rye and potato flours, mangel-wurzel, and a substance resembling acorns, roasted corn, and ground cocoa-nibs,—while as adulterations of the chicory there were instanced deal and mahogany sawdust, carrots, Venetian red, and burnt sugar. The annual consumption of chicory in England when compared with that of coffee shows that the latter must contain about 40 per cent. of the former. But as the English palate likes the taste of chicory, while the individual objects to the trouble of mixing, provision is made by law for the sale of the mixture with a label attached bearing a statement of its character. Nevertheless, so great is the tendency to adulteration, that in 1879, out of 1,244 samples of coffee examined by the analysts, 236 or 18.9 per cent. contained chicory.

In this country we apparently prefer our coffee pure, as the common practice is to purchase the roasted beans and grind them as required; and although we are occasionally quoted as being responsible for wooden nutmegs, we have never been accused of manufacturing coffee beans from compressed chicory as has been done in England. Most of the dealers with whom I have conversed have been strong in their belief that adulterated coffee is not to be found in this country, as the beans are either home-ground or ground by the supplying grocer. The results of H. B. Hill's examination for the State board of health of Massachusetts sustain this opinion, as ten samples of ground coffee obtained in bulk were found to be pure, while seven package samples consisted of one with no coffee, two with very little, and four with from 50 to 70 per cent. of coffee, the rest being roasted wheat, pease, beans, and chicory. But the supplying grocer is not to be trusted in all cases, as out of the few purchased samples of loose ground coffee which have been examined during the present investigation one contained a small percentage of chicory while two consisted largely of chicory and roasted beans. Only one sample of package coffee was received and it sustained the accuracy of Dr. Hill's results. Chicory, corn, wheat, and rye were noted on the microscopic field as adulterants; but adulterants of what?—for no coffee had been discovered, and half a dozen successive slides carefully examined failed to show the presence of the nominal article.

Three extracts or essences of coffee were examined, one of which consisted of chicory and the two others of roasted starches. Two of these bore on the label an offer of a reward for proof that any other extract of coffee was as pure as they, which does not say much in a general way for the purity of extract of coffee. Two samples of chicory were examined, both of which were found pure.

In the following tabulation of the results the letters A and Z respectively represent, as in the case of the teas, the presumption as to quality:

	A	Approved.	Condemned.	Z	Approved.	Condemned.
Loose coffee	5	5	.....	24	21	3
Package coffee	.....	.....	.....	1	.....	1
Essence of coffee	.....	.....	.....	3	.....	3
Chicory	.....	.....	.....	2	2	.....
Total	5	5	.....	30	23	7

SUGARS AND SIRUPS.

At the time of the food adulteration agitation in England, sand in sugar was a phrase familiar to the ears of the people. But it seems probable that in most instances the sand was the result of imperfect

refining and careless handling. Most of the sugars then examined were dark in color, mixed with much vegetable extractive and swarming with the sugar-mite. The sugars now in the market are infinitely cleaner and the *acarus* is seldom seen. Nevertheless, in most of these, the microscope can discover dust particles which would give the sensationalists a verbal license for an outcry of impurity. But the dust in sugar discoverable by the micoscope is like the motes in the air, which require the sunbeam to make them visible.

The health department of the city of New York in its third annual report, 1873, gives a record of the examination of 109 powdered sugars which agrees with the results obtained during the present investigation: 45 were pure and good; 51 contained accidental dust; 8 contained considerable dust or dirt; 5 were very dirty, but in no case was there any intentional adulteration.

Of the 124 samples of all kinds of sugars which are recorded hereafter, 57 were microscopically clean, 64 contained accidental dust, 3 were foul and swarmed with the sugar-mite.

Of late years a saccharine substance, glucose, less sweet than cane sugar, but so far as known possessing all its nutritive qualities, has been manufactured from starch by boiling with sulphuric acid and afterward removing the acid by means of lime. It has been asserted that this substance is largely used for the fraudulent adulteration of sugars.

In 1879 the public analysts of England examined 234 sugars, and found but one of the specimens adulterated. The 109 samples of powdered sugar reported by the health authorities of the city of New York in 1873 were free from glucose, and the purity of the sirups and brown sugars sold in that city was also established. In the absence of experimental proof concerning the condition of the sugars at the present time, these facts might be quoted as indicating the probabilities. As it is, they are mentioned to show how little value such quotations may possess. Adulteration by glucose is certainly practiced, and its extent may be suggested by the following figures: Among 47 brown sugars, most of which were furnished by dealers who knew that their samples would be examined, there were found 3 which contained glucose, while among 38 samples purchased for analysis, no less than nine were thus adulterated. The glucose varied from a small admixture of 30 per cent. A remark by one of the dealers who furnished a 30 per cent. sugar is worthy of mention in this place: "*Oh!* they all have it, but they don't send any of it to *you.*" Another store-keeper from whom a degraded sugar was obtained remarked, as he was putting up the samples, that I was welcome to anything he had, as he did not suppose he was any worse than his neighbors.

The white sugars, powdered, granulated, &c., were free from this adulteration; 24 of them were furnished by dealers and 15 were purchased. The sirups also, of which 21 were sent in for examination and 12 purchased, were also pure. Professor Kedzie, in the Michigan State Board of Health Report, 1874, gives a record of the examination of 17 sirups, only 2 of which were pure; the others were glucose, and contained sulphate of iron and lime. The lowest stated quantity of the iron salt is 25 grains per gallon; of the lime 100 grains; and the highest 58 grains of the former, and 724.83 of the latter per gallon. At that time the glucose must have been put on the market as sirup, while it now appears as sugar. But the glucose sugars are of superior make to Professor Kedzie's sirups. None of them show any free sulphuric acidity or excess of iron or lime. They are indeed a wholesome article of food. Starch is changed into glucose during digestion. By making use of corn-meal or wheaten flour one can furnish his system with all the food elements which are contained in cane sugar or in glucose. So far as nutrition is concerned, there is no occasion for paying a price to the manufacturer as a middleman. But sugar and glucose have an economic value as sweeteners which starch has not; and as this value is greater in the sugar, the presence of glucose, an article of less price as well as of less economic value, is a fraudulent, although not an unwholesome, adulteration of the sugar. Starch sugar, properly prepared and sold as glucose, and at the price of that article, would be a boon to the poor. Many of them use it now, in part, but pay the price of cane sugar for it.

No tin or other unwholesome substances, sometimes stated to be used by refiners, were found in the specimens.

In tabulating the results, A and Z represent the origin and probable quality of the specimens as already explained.

	A.	Approved.	Condemned.	Z.	Approved.	Condemned.
Loaf	......	......	......	2	2	......
Crushed	......	......	......	1	1	......
Pulverized	8	8	......	10	10	......
Granulated	16	16	......	2	2	......
"A"	8	8	......	1	1	......
"C"	9	9	......	......	......	......
Various	30	27	3	37	28	9
Total sugars	71	68	3	53	44	9
Sirups	21	21	......	12	12	......

FLOUR.

The results of the flour analyses are highly gratifying. Of 58 specimens which were examined only one contained matter foreign to the wheat kernel, and in this case the adventitious substance was corn-meal, evidently introduced by accident. Five samples were so deficient in gluten that it is doubtful if good bread could have been made from them; but this arose not from willful adulteration, but from natural causes. Our merchants have so many flours rich in gluten that a poor flour should not be found in the markets. Mixing or blending is permissible in the case of flour. Ten to twelve per cent. of gluten is required to make good bread. Some believe that better bread can be made from a 10 per cent. sample than from one which contains a larger quantity of gluten, but this is questionable. Mr. Brown, a flour dealer of large experience, testified before the English food committee that he endeavored to meet the wants of the bakers by mixing bean flour with his wheat in order to increase the quantity of nitrogenous matter. According to his statement, the loaf should be of white color and of a good height, the corners free from a doughy skin, the crust not to dye of a brown color. It should cut with smoothness, with a plane surface, and no large holes. To obtain this loaf from English flour, which contains only 10 per cent. of gluten, the addition of a small percentage of bean flour was necessary. But in this country, with flour which contains as much as 17.5 per cent. of gluten, there is no occasion for the use of beans. The starch and other nutritive principles of a weak flour can be utilized in bread-making by mixture with flour of stronger or more glutinous quality. A certain percentage should be prescribed as the minimum consistent with marketable quality. Nine per cent. has been chosen as the minimum in making out this report, which returns 5 of the 58 specimens deficient, but perhaps this minimum is too low; it is certainly not too high.

Twenty-five years ago, in England, Normandy testified that he had scarcely found a flour which did not contain alum to some extent. Improvement has taken place since then, mainly through conviction under the food-adulteration act. Yet last year the English analysts found in 601 samples of flour 15 specimens or 2.4 per cent. adulterated with alum.

BREAD.

But although our millers and flour dealers do not make use of alum, there is no doubt as to its employment by the bakers. Of 18 samples purchased in the city of Washington, D. C., 8 contained it. Long ago Hassall reported to the English food committee 24 samples in which alum was present in all, while Normandy expressed the prevalence of the practice by reporting that he had found one bread in which alum was *not*. The British analysts, in 1879, examined 1,287 breads, of which 95 or 7.3 per cent. were reported against as being adulterated with alum, and since the use of this substance is prohibited by the adulteration act, it is clear from the continuance of the practice that the bakers must find it to their advantage. But, on general principles, the advantage to the public of what is profitable or advantageous to the bakers would seem to be doubtful.

The unwholesomeness of alum is by no means universally accepted. If the alum existed in bread as alum, and was introduced into the system as such, it would, from its powerful astringent properties, interfere materially with digestion, and be properly viewed as a deleterious ingredient. But it is well known to chemists that when water is added to alumed flour in the process of dough-making, a chemical change takes place whereby the alum is converted into an insoluble powder. This insoluble powder, which is generally believed to be inert, has been proved by Professor Patrick, of the University of Kansas, to be unaffected by the juices of the stomach. Alum would, therefore, appear to be harmless. But there is another view to be taken of the subject, looking to its action in the bread itself. One of the objects of its introduction is to check the process of fermentation which may be taking place in poor flour, so that the bread made therefrom is whiter and contains less dextrin and starch-sugar than if no alum had been added. So far its action is preservative and of value, but it is accomplished at the expense of the nutritive principles of the flour. Phosphoric acid, from the soluble phosphates of the grain, is precipitated along with the insoluble alumina in the bread-making process; and, what is of more consequence, the digestibility of the bread is impaired by the presence of the alumina and its phosphate. J. West-Knights, F. C. S., in a paper read before the Society of Public Analysts during the present year, records the results of digestive experiments on alumed and unalumed breads. The former left a larger residue of unsolved matter after treatment with an artificial gastric juice. Nevertheless there are no cases on record where disorder of the digestion is unmistakably due to the use of alum. There are many declamatory and unsound passages in books concerning the unwholesomeness of alum in bread; but, impartially viewed, the evidence appears to give ground for regarding it as an adulteration which should be suppressed. As alumed baking-powders are in such general use, this subject is worthy of a thorough investigation.

Dr. Elwyn Waller, in the Fourth Annual Report of the Health Department of the city of New York, reports upon the bread sold in that city: Of 51 samples 41 contained no adulterant; 2 contained copper, probably added as sulphate; 6 contained an excess of alumina, and 2 both alum and copper.

Alum, however, was the only adulteration found during the present investigation.

CORN-MEAL.

The corn-meal gave such satisfactory results that it was deemed unnecessary to continue the investigation after twenty samples had been examined. These were found to be of excellent quality and free from any extraneous matters. Sixteen of the twenty were obtained by purchase.

LARD.

In England lard has been found much adulterated with potato-flour, water, salt, carbonate of soda, and caustic lime; but of fourteen samples purchased in Washington City all were found to be of excellent quality. The results being so uniform, it was considered unnecessary to increase the number of samples.

BICARBONATE OF SODA.

Commercial bicarbonate usually contains a small percentage of sulphates and chlorides, and a specimen is rarely found which does not present traces of sulphur salts. These impurities are accidental, and can only be regarded as an adulteration when the percentage is unusually high. Of the 12 samples which were examined, 9 were poor specimens of the commercial article, 2 contained about 10 per cent. of impurity, enough certainly to condemn them as failing in purity; while 1, from exposure or imperfect preparation, showed a deficiency of carbonic acid corresponding to the presence of 25 per cent. of the neutral carbonate. No markedly fraudulent adulterations, as with large percentages of terra alba or starch, were discovered; but it is probable that if the list of samples had been increased some notably bad specimens might have been obtained; for in 28 samples reported in the Third Annual Report of the Health Department of the city of New York, while 26 were of the ordinary commercial character, 1 contained flour, and 1 nearly 25 per cent. of terra alba.

CREAM OF TARTAR.

Commercial cream of tartar contains tartrate of lime, which must, within limits, be accepted as natural to it. Some cases have been tried recently in England in which the adulteration charged was the lime tartrate present in this salt, but the magistrate properly refused to convict. Were this the only ground of complaint against the cream of tartar of the grocery stores, it would pass with the bicarbonate as being generally of ordinary purity; but unfortunately this is not the case. It is, on the contrary, one of the articles which are subject to gross adulteration. Only 18 samples were examined, but these were considered to be enough, in view of the character of the results. Six were of satisfactory purity. Eleven contained sulphate of lime, varying from 17 to 90 per cent.; three having nearly the latter figure. Two contained no cream of tartar, but consisted instead, the one of sulphate of lime, alum, and acid phosphate of lime, and the other of alum, acid phosphate, and potato-starch. Corn-starch was also found in large proportion in one of the lime sulphate powders. Considering the use of cream of tartar in baking, its impure condition is a serious evil.

The samples examined cannot be considered as exceptionally impure, for similar results have been recently reported by the Massachusetts Board and the New York City Health Department. Of nine New York samples, one had 86 per cent. of terra alba, one 61 per cent., and the others contained this lime-salt, but the quantity was not determined.

BAKING-POWDERS.

Eighteen specimens were obtained, 6 of which were purchased, while 12 were furnished by the Commissary-General of Subsistence of the Army in unopened sample-cans. The acid salt of the latter consisted in every instance of cream of tartar. Of the purchased specimens one contained alum, another acid phosphate of lime, while the remaining four consisted of a mixture of these two salts. The alkaline salt was in all bicarbonate of soda. The starch used in the manufacture was generally corn-starch, but wheat-starch and wheat-flour were found, and mixtures of these, with corn-starch. In one case powdered gum took the place of the starches. Small fragments of woody tissue existing as impurities in the gum were probably intended to suggest to the public the presence of ground malt. One of the starch powders was flecked with minute woody particles, probably with a similar intention. The quantity of starch varied from 6 to 55 per cent., but the value of a baking-powder depends, other things being equal, on the amount of carbonic acid which it furnishes during its decomposition. The gas in these samples ranged from 4.1 to 16 per cent. of the weight of the powder. The price, however, was not the same in all cases, so that the powder which yielded the largest percentage did not necessarily supply the gas at the lowest price. Again, some of the cans contained in excess of their nominal weight, while others were deficient. The materials in every instance appeared to be of good commercial quality, to be thoroughly mixed, and to be pretty well proportioned, the excess, except in one case, being on the side of the bicarbonate, to prevent undue acidity in the articles of diet prepared by their aid.

Nothing can be said against the cream of tartar powders, except that some of them were deficient in active properties (4.1 per cent.), which would correspond with a dilution or adulteration by starch. A minimum limit is needful in these cases.

The acid phosphate powders contain a percentage of sulphate of lime, which is due to the method of manufacture. It is unlikely that the quantity present in a carefully prepared powder would be unwholesome. When sold as phosphate powders and at the cheaper price of phosphate powders, there is, from the point of view of this report, no objection to their use, provided a limit is placed upon the accidental lime sulphate so that it may not form the nucleus for willful additions.

The alum samples must be considered as adulterated baking-powders since none of them gave information by the label concerning their character. They are imposed upon the public by manufacturers and dealers in the effort to undersell each other, and are sold on the merits, if not by the name of cream of tartar powders. But if these powders were sold as alum powders, and at the price of alum powders, there would be no adulteration. Thus while alum in bread would be considered and treated as an adulteration, alum in baking-powder might have to be reported as pure. A label in such a case would diminish the sale, but would not prevent the use of these powders among those who most require supervision in sanitary matters—the poor and ignorant. A proscription of alum from bread and baking materials would be required to afford them effectual protection.

BLACK PEPPER, GROUND.

The examination of the ground black peppers and spices shows to what extent adulteration may be practiced when its detection by the public is a matter of difficulty. The dealer himself appears to have lost the knowledge of the characters of the pure article, as out of four samples sent in by respectable houses in this city for the purpose of being examined only one was pure. The others contained baked flour and rice with sand enough to prove the unclean condition of the peppers when milled.

In 1855 Dr. Hassall reported 43 specimens from the English stores, 16 of which were adulterated, 4 with wheat-flour, 1 with pea-flour, 2 with rice, 4 with mustard, 3 with linseed-meal, and 2 with P. D., which last was understood to be a trade name for a mixture of linseed cake, mustard dross, and cayenne pepper, used by black pepper manufacturers. The chemist of the board of internal revenue gave the results of a larger experience. Of 1,116 peppers, 576 were adulterated with rice, sago, potato-starch, burned chillies, brown and white mustard, wood, wheat bran and flour, oat-flour, and ground gypsum. This unsavory record is not improved by the results of the present examination. Four of the specimens have been already mentioned. The Commissary-General supplied 16 unopened sample-cans for investigation. Of these, 2 were adulterated with fresh and baked wheat-flour, while 6 showed from the quantity of sand present the unclean and probably inferior quality of the peppers. Of 32 samples which were purchased 4 were pure, but the sand showed their inferior character, 3 per cent. in one case being perhaps more than ought to be allowed as consistent with purity. The remaining 28 samples were mixed with large percentages of baked flour, rice, corn, beans, mustard, and linseed husks, cayenne, and turmeric. Three, 4, and 5 per cent. of sand were also found in some of them. In the case of sugar, the microscopic dust was specified as being of no practical account. Here, on the contrary, the substances mentioned, which were discovered by microscopic examination, constituted the body of the sample, pepper having been added simply as a flavoring agent.

ALLSPICE, GROUND.

This substance, which was found by the English committee to be seldom adulterated, is with us largely mixed with such articles as bread-crusts, beans, corn-starch, woody tissues, and turmeric. Five samples from sources which presupposed purity were found to be pure; but of 23 which were purchased 11 were allspice only in name.

GINGER, GROUND.

Dr. Hassall reported 15 specimens out of 21 as adulterated with sago, potato, wheat, and rice starches, cayenne, mustard, and turmeric. The present examination revealed the presence of similar adulterants. Five specimens, which came from good sources, were pure; but one of them contained 3 per cent. of sand, which is too high to be accidentally present in a good article. Of 11 purchased samples 6 contained wheat-flour, corn-starch, rice, bran of wheat, husks of black pepper, and turmeric. Some of these contained over 5 per cent. of sand.

MACE, GROUND.

Only 8 samples of mace were purchased, as the uniformity of the results indicated the prevalence of adulteration. Most of these contained very little mace, but were mainly composed of corn and wheat flours and starches, wheat-bran, rice, beans, and turmeric. Even the three samples which were voluntarily presented by first-class houses in this city were not all pure. One was mixed with wheat-starch.

CLOVES, GROUND.

Four samples from unexceptionable sources were found to be pure; but only three of the 20 purchased specimens were free from other and cheaper vegetable substances. Allspice constituted in several instances the bulk of the so-called cloves, alone, or usually mixed with large percentages of corn, wheat, and beans.

CINNAMON, GROUND.

Out of 26 samples of ground cinnamon one was found to be unadulterated. This exceptional specimen came from the office of the Commissary-General of Subsistence, United States Army. Two others which were furnished from that office were adulterated with almond-shells, roasted beans, and various starches. The single sample which was sent by a first-class Washington dealer contained baked wheat-flour. Of the 22 purchased specimens, 3 would have been reported pure if they had been sold as cassia, but the others contained, in addition to cassia, corn, wheat, beans, allspice, almond-shells, and turmeric. Three contained also an unwarrantable quantity of sand and red clay.

CAYENNE PEPPER, GROUND.

Two samples of pure cayenne were found; one was furnished by a dealer in Washington, the other was a purchase in that city. On the other hand, three sample-cans from the office of the Commissary-General and 13 purchased samples were adulterated. The adulterants were generally corn flour or starch and turmeric, but fresh and roasted wheat, rice, linseed, log-wood, deal sawdust, and red clay were also found. The only gratifying point in connection with these samples is the absence of red lead, a deleterious addition, which Hassall found in 13 of 28 English specimens.

MUSTARD.

Of 27 samples examined 6 were found to be pure, but 4 of these were obtained from the medical purveyor, and were intended for medicinal purposes, while 2 were purchased in Washington City. Of the 21 adulterated specimens 2 were furnished by dealers and 19 purchased. The adulterants were principally wheat starch or flour and turmeric, but corn-starch, rice, cayenne, and sulphate of lime were also found.

VINEGAR.

The only adulteration discovered in the 15 samples of vinegar which were examined was dilution by water. The strength varied from 2.56 per cent. of monohydrated acetic acid to 7.12 per cent. A minimum limit must be established. Allowing 3 per cent. to constitute this limit, 3 of the 15 would have to be condemned. Iron was present in some of the samples, but only in traces. No copper, lead, or other dangerous metals were found, nor any free mineral acids. The Third Annual Report of the State Board of Health of Massachusetts, 1872, gives the result of the examination of 12 cider and 10 wine vinegars. Of the former, 1 contained free sulphuric acid, while 8 of the latter showed traces of free acid, and 2 contained lead.

PICKLES.

Only one sample was furnished for examination—the pickles of the Navy ration. They were of good quality and free from copper coloring and mineral acids.

Recently E. H. S. Bailey, of the Lehigh University, examined a bright green pickled cucumber weighing two ounces, and found it to contain copper equivalent to one-seventh of a grain of the sulphate. H. B. Hill, assistant in chemistry at Harvard College, examined 12 pickles (probably selected on account of their suspicious color). Ten of the specimens contained copper in quantities varying from .0009 to .0077 per cent.

COLORED CONFECTIONERY.

No quantitative examinations were made, as the time at command did not permit, but as poisonous agents are reported to have been used for coloring confectionery it was deemed important for the purposes of this report to make at least some qualitative investigations. Most of the candies which were purchased were red—13 samples—and owed their color to cochineal; but a sufficiency of yellow colored specimens were obtained to show that lead continues to be the basis of such colors. Of 5 yellows, 3 contained lead, 1 antimony, and 1 turmeric.

These candies, excluding from consideration the poisonous coloring matter, were of great purity. All were made from cane sugar, and were free from sulphate of lime and practically free from starch. The largest quantity of starch was found in some solid looking lozenges which contained a small proportion of baking powder, by means of which the starch was apparently introduced.

In the third annual report of the New York City health department a record is given of 10 yellow-colored candies, 5 of which contained lead and 1 gamboge. But H. B. Hill, of Harvard College, has made the most complete investigation into this subject. He examined 77 samples. Of these 24 contained a small and 14 a large percentage of starch, while 5 contained a small and 2 a large percentage of sulphate of lime—one of the latter having nearly 60 per cent. Lead was reported present in 19 of 21 yellows and 11 of 12 orange colors. In 29 reds, 3 contained iron, 1 mercury, the rest having vegetable coloring matter. In 5 browns, 4 contained iron. In 4 blues, 2 contained ultramarine; and in 7 greens, 6 contained Prussian blue, with lead, and in one case arsenic.

E. H. S. Bailey, of Lehigh University, kindly furnished the writer with notes of an examination of a yellow-colored candy sold as lemon balls. The color was due to chromate of lead, which was present in such quantity as would give 7 grains of metallic lead in every pound of the candy.

Summary of the articles examined, with the results.

[Those returned as condemned were of such a character as would justify prosecution in case of the existence of a law to prevent the adulteration of food.]

	A			Z		
	Number.	Approved.	Condemned.	Number.	Approved.	Condemned.
Teas:						
Congous	6	6		2	2	
Pekoes	2	2				
Oolongs	31	31		4	4	
Gunpowder	29	29		2	1	1
Imperials	12	12		7	3	4
Hysons	7	7		3	3	
Japans	11	11		1	1	
Coffee:						
Loose	5	5		24	21	3
Package				1		1
Essence				3		3
Chicory				2	2	
Sugar:						
Loaf				2	2	
Crushed				1	1	
Pulverized	8	8		10	10	
Granulated	16	16		2	2	
"A"	8	8		1	1	
"C"	9	9				
Various	30	27	3	37	28	9
Sirups	21	21		12	12	
Flour	30	27	3	28	26	2
Corn-meal	4	4		16	16	
Lard				14	14	
Bread	1	1		18	10	8
Baking-soda	1	1		11	8	3
Cream of tartar	1	1		17	5	12
Baking-powders	12	12		6	1	5
Black pepper	20	15	5	32	4	28
White pepper	1	1				
Allspice	5	5		23	11	12
Ginger	6	5	1	11	5	6
Nutmegs				1		1
Mace	3	2	1	8		8
Cloves, whole				5	5	
Cloves, ground	4	4		20	3	17
Cinnamon, whole				1		1
Cinnamon, ground	4	1	3	22		22
Cassia	2	1	1			
Cayenne	4	1	3	14	1	13
Mustard	6	4	2	21	2	19
Vinegar	6	4	2	9	8	1
Pickles	1	1				
Confectionery:						
Red				13	13	
Yellow				5	1	4
	304	280	24	409	226	183

Percentage of condemned articles in A=7.89.
Percentage of condemned articles in Z=44.74.

APPENDIX.

In the tabulation of the examined articles the capital letters prefixed to their number indicate the source from which each specimen was obtained. Where the presumption of purity attaches to the source, as in the samples furnished by dealers who were aware of the object in collecting them, one or other of the initial letters of the alphabet is chosen; but where the presumption is in favor of adulteration, as in articles purchased in the poorer districts of this and other cities, with no knowledge on the part of the dealer of the object of the purchase, one or other of the terminal letters is used.

Thus A indicates that the specimens were furnished by the better class of dealers in Washington City;

B, that they were obtained by the Commissary-General of Subsistence, United States Army, from mills, factories, or wholesale firms;

C, that the samples came from the Paymaster-General of the Navy;

D, from the Chief Medical Purveyor United States Army; and

E, from the Commissioner of Agriculture; while

W, were purchased in Washington City;

X, in Tennessee;

Y, in New York City; and

Z, in Baltimore, Md.

TEAS.

A little uncertainty was felt as to the best method of dealing with the teas, not so much for the detection of adulterations as for the grading of quality. In cases where the medicinal properties of a vegetable substance are dependent on the existence of an alkaloid the estimation of the active principle suffices to indicate the character and market value of the sample. But the alkaloid of tea does not constitute its only active principle. The volatile oil on which the aroma of the infusion depends is an important constituent.

Moreover, the methods for the extraction of the alkaloid are uncertain, or some analysts must have met with very anomalous specimens, as the theine has been found to range from .43 per cent. in Mülder's analysis to 6.21 in Péligot's (quoted by Hassall).

Tannin is generally regarded as of importance, and most published analyses contain a statement of its amount. Before commencing operations on the following teas several processes were tried for the estimation of the tannin, but by none of them could satisfactory results be obtained.

With the view of determining what processes were really of value in an investigation which was intended not only to detect the presence of foreign substances, but also the mixture of inferior with better grades of the genuine article, a series of experiments was instituted on each sample. The moisture was obtained by drying in an air-bath for twelve or fifteen hours at a temperature of 200–212° Fah. This loss of weight was required partly as showing a well or poorly preserved or prepared article, but chiefly that the other results, when obtained, might be made susceptible of comparison by reducing them to percentages of the dried tea. The ash, weight, and alkalinity of that part of it which was soluble in water and the weight of its siliceous residue were determined. The gum was precipitated from an extract by alcohol, dried, weighed in a weighed filter, the weight of its ash being deducted from the result. The extractive was obtained by a thorough exhaustion in the water-bath with successive waters. A similar infusion evaporated with magnesia and treated with ether for forty-eight hours was relied upon for the extraction of the alkaloid. The whole of the theine may not have been dissolved by this means, but as all the teas were treated by the same process the results necessarily have a comparative if not an absolute value.

In looking over the figures in the following tabular statements, it is found that the moisture varies from 2.70 in the Japans to 9.12 in the congous, the average being for the congous 8.09, the pekoes 6.41, the oolongs 6.82, the imperials 6.50, the gunpowders 5.98, the hysons 6.61, and the Japans 4.69 per cent.

From the manner in which the leaves are collected and prepared, it is manifest that a certain amount of sand and clay must be incorporated with the commercial article, which will increase the amount of ash and show itself again in the insoluble siliceous residue. But as Oolong A 18 and Japan A 3 show only .13 and .16 per cent. of silica, it is evident that the quantity of this substance naturally present in the leaf must be very minute, and that any slight increase must be considered an accidental impurity, owing to carelessness in preparation, and probably corresponding with an inferiority in the market value of the leaves containing it. Some exceptions must be made to this inference, as sand and minute pebbles may be added to an otherwise superior article for the sake of the gain in weight, as appears to have been the case in gunpowder A 26 and 27. Where the silica is high, as in imperial W 2, there is no doubt as to the fraudulent character of its presence.

In general terms, where the silica is low, say under .50 per cent., we are dealing with a clean and probably superior article. Where it exceeds this amount, but is under 1 per cent., the specimen is an inferior tea carelessly prepared, or a good article willfully adulterated before shipment, as it can hardly be supposed that our home dealers would tamper with a fine article in this petty manner; and where it is present in large excess there is no doubt as to the fraudulent intention.

Corresponding with this excess in the silica is the excess of weight in the ash. Of the teas given below, those samples which have less than .50 per cent. of silica have an ash weighing on the average among the oolongs 6.29 and among the greens 6.20 per cent. The silica is so high among the congous, no doubt owing to exposure during fermentation, that none of them enter into this calculation. These figures may be viewed as representing the ash of good commercial articles. A slight increase over them corresponds with inferiority in quality, and a large increase, as in imperial W 2, with fraudulent admixture. On the other hand, exhausted leaves may correspond with a good showing in the ash and its residue, as is seen in imperial Y 1.

The soluble ash, its alkalinity, and the quantity of theine are proportioned, generally speaking, to the quality of the sample, but there are so many exceptions, old leaves often showing higher figures than younger, higher priced and evidently more carefully prepared specimens, that these determinations are deprived of much of their value.

The gum is so variable that nothing can be learned concerning the quality of the tea from its estimation. It is noticeable that this ingredient is high in the Japan teas.

The extractive varies from 25.8 among the congous to 46.6 per cent. among the gunpowders, the average being for congous 28.88, pekoes 37.75, oolongs 37.25, imperials 35.14, gunpowders 38.78, hysons 36.76, and Japans 39.41 per cent. Where the extractive falls below 20 per cent. in a congou, or 30 per cent. in any of the others, the probability of an admixture of exhausted leaves or other deteriorating substances is very great.

A. W. Blythe in his Manual of Practical Chemistry says that "the time is probably not far distant when the tea trade will buy entirely by analysis, supplemented in a few cases by a taster's report. An experienced palate will detect particular flavors which analysis may fail to show, but a fairly complete chemical examination of tea is of the highest value, whether as a guide to the purchaser, or merely to show its freedom from adulteration." The analyses given below fail to support this prediction. On the contrary it would appear that a careful examination of the general characters of the sample by one who has some experience to guide him will give better indications of quality and do as much for the detection of adulteration as the fairly complete chemical analysis. The leaves of the different brands have distinct characteristics. Congous and oolongs are small and whole or larger and divided transversely, each piece being more or less carefully rolled or twisted. Gunpowders are small, young leaves, rolled into pellets; imperials, larger and older leaves, similarly rolled; hysons, elongated leaves, rolled into cylinders which are bent on themselves or rolled into loose pellets; Japans, rolled and twisted or compressed. The quality of the leaves is usually proportioned to the perfection of the rolling and the freedom of the sample from dust or broken fragments. Exhausted and redried leaves can be picked out by an expert and an extract made and weighed to corroborate the suspicion. It is probable that an estimation of the gum might be of value in this connection. When the leaves are unrolled by the action of boiling water foreign leaves can be detected and the value of the sample, if genuine, can be approximated according as it consists of young and perfect leaves, of fragments of older ones, of buds, of dust, or of woody petioles and midribs. Facing can be seen in the cloudiness of the infusion and in the pulverulent sediment, where sand and pebbles can also be detected if existing in quantities sufficient to indicate their fraudulent presence. The weight of the ash and of its silica will give expression to this adulteration.

The Japan teas (*a*) were sent from Yokohama by Dr. Thomas H. Street, U. S. N., to enable a comparison to be made with those in the markets of this country. A large consignment of specimens (178) has been received through the State Department from the consul-general at Shanghai. The principal varieties of Chinese growth are represented in this series, but they unfortunately did not arrive in time to permit of their examination in connection with this report.

The specimens sent by Commissioner Le Duc of the Agricultural Department were grown in Georgia. Their deficiency in gum is remarkable.

All the experiments were made on the moist article, but the figures recorded represent percentages of the dry tea. The alkalinity is expressed as anhydrous potassa.

CONGOUS.

		Moisture.	Ash.	Soluble ash.	Alkalinity.	Silica.	Gum.	Extractive.	Theine.	Price per pound.	Remarks.
A.	1	7.50	6.85	3.18	1.40	.54	5.51	25.8	1.54	$0 75	Leaves, ¾ to 1½ inches, but mostly broken; some of the smaller whole; many petioles.
	2	7.42	7.32	3.26	1.29	.62	5.40	26.3	1.40	1 00	Many fragments, but a large proportion of the leaves whole, 1½ inches long; many petioles.
	3	9.12	7.04	3.12	1.33	.72	6.38	34.1	1.43	1 00	Leaves small and whole or large and divided.
	4	8.00	7.78	3.04	1.25	1.56	6.63	28.4	1.55	60	None whole; all broken or divided transversely; many petioles.
	5	8.48	6.47	3.39	1.48	.76	4.26	30.7	1.67	80	Leaves ¾ to 1½ inches; the smaller whole, the larger divided; many broken.
	6	7.94	7.32	3.80	1.69	.87	4.89	30.9	......	90	Leaves young, but all divided into two or three pieces.
W.	1	8.76	6.97	......	......	.96	....	28.1	1.42	....	Much tea dust; no whole leaves; all divided originally, but broken into small fragments now.
	2	7.48	7.54	2.66	1.42	1.51	6.16	26.7	1.84	....	

PEKOES.

		Moisture.	Ash.	Soluble ash.	Alkalinity.	Silica.	Gum.	Extractive.	Theine.	Price per pound.	Remarks.
E.	1	7.36	6.24	3.20	1.29	.63	1.10	34.6	1.43	....	Marked "Broken Pekoe." Fragments of small young leaves.
	2	5.46	6.09	2.88	1.43	.30	.95	32.9	1.20	....	Marked "Pekoe Souchong." Leaves divided; a few whole, ¾ to 1¾ inches long.

OOLONGS.

	Moisture.	Ash.	Soluble ash.	Alkalinity.	Silica.	Gum.	Extractive.	Theine.	Price per pound.	Remarks.
A. 1	5.16	5.97	3.79	1.40	.45	5.69	33.2	1.61	$0 50	All in fragments; when whole, 1¼ to 2½ inches; many petioles.
2	6.48	6.41	3.44	1.31	.19	5.56	38.3	1.92	1 25	"Foochow." Leaves divided; many whole, 1½ inches.
3	6.85	6.97	3.28	1.23	.43	6.76	33.4	1.32	70	Many large leaves whole and many leaf-stalks.
4	6.60	6.77	3.17	1.37	.85	6.85	36.7	1.45	1 00	Broken, but the whole leaves small and young.
5	6.48	6.24	......	......	.38	......	......	1.68	60	Leaves nearly all broken.
6	6.20	6.30	......	......	.43	......	......	1.38	50	Mostly whole, large, old, leathery, and with woody petioles.
7	6.50	6.45	......	......	.43	......	......	1.31	50	Leaves large and broken; a few small ones whole; many woody petioles.
8	6.42	5.93	3.84	1.62	.38	10.00	36.8	......	80	Large leaves, 1½ to 2½ inches, mostly whole; midribs and leaf-stalks tender.
9	6.00	7.02	3.62	1.60	.91	2.34	34.3	1.28	1 00	Leaves mostly whole; some petioles and twigs.
10	6.60	6.79	......	......	.48	......	......	1.42	75	Mixed leaves, large and small; all more or less broken, and many petioles.
11	6.30	6.40	......	......	.77	......	......	1.46	50	A few large whole leaves and much tea dust.
12	6.92	5.97	......	......	.43	......	......	1.79	90	"Formosa." Leaves whole or cut transversely; many petioles but all soft, and little dust
13	6.76	6.15	......	......	.77	7.72	39.4	......	75	Leaves ¾ to 1½ inches; the smaller whole, the larger divided.
14	7.30	5.66	......	......	.48	8.74	41.6	......	1 00	Leaves ¾ to 1½ inches, mostly whole; many soft petioles.
15	2.24	6.14	......	......	1.02	9.10	36.8	......	50	Leaves 1 to 1½ inches; many petioles; wiry.
16	7.34	6.30	3.23	1.14	.53	12.80	39.4	......	1 00	Mostly whole or divided; few fragments.
17	7.40	7.71	2.74	1.39	.97	10.05	33.8	......	50	Ash is properly 6.26 per cent., as a small piece of quartz, weighing .072 grams, was found in the 5 grams ignited.
18	7.48	6.14	......	......	.13	8.00	44.0	1.34	1 00	Leaves mostly whole; some divided; ¾ to 1½ inches.
19	7.64	6.43	......	......	.58	4.98	40.0	1.13	50	Leaves ¾ to 1½ inches; smaller whole, larger divided; many petioles.
20	7.62	6.50	3.68	1.69	.43	13.00	37.0	......	50	Leaves 1¼ to 2¼ inches; many broken; much woody tissue in petioles and midribs.
21	7.89	6.08	3.06	1.49	.43	7.16	38.5	......	50	Leaves old and woody; large and whole, or divided.
22	8.28	6.76	3.40	1.24	.48	6.32	37.2	......	90	Leaves 1 to 2 inches; many whole; some divided or broken; petioles soft.
23	7.36	6.26	3.22	1.50	.43	11.50	39.6	......	50	As the last, but petioles and midribs hard.
24	7.36	5.90	3.61	1.50	.43	6.70	37.4	......	50	Mostly fragments of old and tough leaves.
25	6.60	6.32	3.73	1.56	.32	6.64	36.6	......	75	Leaves mostly whole; 1 to 2½ inches; some of the larger divided.
26	8.66	6.50	3.17	1.41	.68	11.60	36.9	1.40	33	As the last, but with many fragments and woody petioles.
27	7.04	6.58	3.25	1.53	.56	6.56	35.2	......	50	Many whole leaves; some fragments and petioles.
28	7.34	6.62	3.62	1.50	.49	8.42	37.7	......	75	Leaves 1 to 1½ inches; mostly divided; some very broad.
29	5.80	6.07	3.91	1.63	.55	8.92	38.0	......	50	Leaves 1 to 1½ inches, divided; a few woody petioles; manganese largely present inthe ash of this sample.
W. 1	7.20	5.82	3.02	1.51	.54	......	37.4	......	......	Leaves ¾ to 1¼; mostly cut; but some whole; few fragments; petioles soft.
2	7.08	6.25	3.49	1.70	.60	......	35.7	......	......	Leaves divided; woody midribs, and many petioles.
3	6.84	6.31	......	1.35	1.12	......	33.8	......	......	Leaves large and elongated; tough and woody midribs, and many petioles.
4	6.90	6.27	......	1.59	.97	......	35.3	......	......	Mostly fragments of large leaves; woody petioles.
D. 1	6.42	6.26	3.86	1.49	.43	3.42	42.1	1.68	......	Leaves large and old; mostly whole; few fragments; much manganese present.
C. 1	7.58	6.53	4.09	1.86	.61	7.90	34.0	1.51	......	Leaves large and divided; edges frayed; many petioles and buds; much manganese present.

GUNPOWDERS.

	Moisture.	Ash.	Soluble ash.	Alkalinity.	Silica.	Gum.	Extractive.	Theine.	Price per pound.	Remarks.
A. 1	5.28	7.14	4.16	1.75	.21	7.60	37.1	2.11	1 40	Leaves ¾ to 1⅜ inches; young; and some broken.
2	4.72	6.72	3.88	1.90	1.09	3.36	32.9	1.26	50	Leaves divided; 1¼ to 1¾ inches, whole and broken; many petioles, and small fragments of charcoal.
3	5.10	6.79	......	......	.42	......	......	1.30	1 00	Many leaves broken; medium in size.
4	4.36	7.99	3.78	1.74	.58	8.26	38.9	.94	70	Leaves young, but much broken.
5	5.84	5.35	3.76	1.68	.27	7.11	38.2	1.06	90	No whole leaves; fragments of medium-sized leaves.
6	6.16	6.99	......	......	.55	......	......	1.31	1 20	Leaves ¼ to ½ inches, largely divided, small whole, no débris.
7	6.04	6.69	......	......	.57	......	......	2.02	1 00	Leaves small, ¾ inch, many broken.
8	5.40	7.66	3.43	1.43	.53	5.92	33.5	1.34	50	Mostly broken fragments of large leaves.
9	5.48	6.42	......	......	.44	......	......	1.69	1 25	Leaves small and whole; some larger ones broken.
10	5.50	6.25	......	......	.40	6.56	42.3	......	......	Leaves young, 1 to 1½ inches; many broken.
11	5.36	7.44	3.34	1.33	1.31	6.66	34.6	......	50	Leaves large and divided.
12	6.84	7.60	......	......	.81	8.04	44.7	......	1 20	Leaves small; generally whole.
13	7.04	7.16	......	......	1.10	5.38	42.4	......	1 20	All fragments of medium leaves.
14	5.45	6.81	4.19	1.64	.48	14.60	33.8	......	1 25	Leaves mostly small and whole.
15	6.24	6.76	3.94	1.76	.38	6.29	46.1	......	1 20	Medium-sized leaves, mostly divided.
16	5.40	7.96	3.53	1.49	1.29	6.66	34.8	......	50	Fragments of large leaves.
17	5.84	7.52	3.63	1.55	1.12	10.19	38.8	......	80	Broken pieces of medium leaves.
18	5.30	6.66	3.85	1.51	.65	10.15	37.4	......	1 25	Leaves small and young; mostly whole.
19	7.72	6.48	3.64	1.43	.91	6.61	36.3	......	40	Fragments of old large leaves; dead flies.
20	6.10	7.41	3.92	1.52	1.06	10.80	44.6	......	1 00	Small leaves whole, but with some fragments of larger and older leaves.
21	7.30	6.54	3.76	1.62	......	11.44	43.1	......	75	Fragments of large leaves.
22	6.50	6.46	3.46	1.44	......	9.62	38.4	......	50	Pieces of large old leaves, with some smaller and whole.
23	6.48	7.36	3.42	1.44	......	12.30	41.9	......	75	Leaves 1 to 1½ inches; mostly whole.
24	6.80	6.76	3.88	1.59	......	8.90	43.7	......	1 00	Small whole leaves, with some fragments of old leaves.
25	6.64	6.58	3.94	1.71	.43	10.90	43.1	......	1 00	Leaves ¾ to 1½ inches; many broken, but no mixing.
26	6.42	8.63	3.52	1.43	1.84	12.10	46.0	......	1 25	Leaves small, generally whole; quartz pebbles size of pin-head in the ash.
27	5.32	7.46	4.16	1.66	1.06	11.63	43.7	......	1 10	Leaves small, generally whole; but some larger ones and pebbles, as in last.
28	4.56	6.81	3.77	1.65	.61	7.86	43.9	......	1 25	Leaves small, but many larger divided: all young.
29	6.34	7.49	3.62	1.39	1.81	10.35	46.6	......	1 25	Five grams contained a fragment of iron weighing 50 milligrams, and some quartz pebbles. Leaves small and young.
Y 1	6.96	7.63	3.03	1.28	.67	7.06	32.4	......	......	Small fragments of old leaves, very coarsely faced.
2	6.90	9.23	3.00	1.28	.94	4.83	34.7	......	......	

IMPERIALS.

	Moisture.	Ash.	Soluble ash.	Alkalinity.	Silica.	Gum.	Extractive.	Theine.	Price per pound.	Remarks.
A. 1	5.44	5.88	3.74	1.58	.30	6.56	35.1	1.59	1 00	Leaves large and mostly whole.
2	5.02	6.19	3.51	1.37	.27	7.58	34.2	1.79	1 25	Leaves ¾ to 1½ mostly whole; a few petioles.
3	5.32	7.06	......	......	.59	......	....	1.37	75	Leaves large and whole; some very large, 2½ inches, divided.
4	5.94	8.12	3.36	1.31	1.33	7.02	31.3	1.24	50	Leaves old and mostly in large fragments.
5	6.54	7.72	3.19	1.33	1.09	4.92	33.5	......	50	Small leaves; large ones divided, and fragments.
6	5.94	6.06	3.19	1.49	.34	6.91	36.1	......	80	Leaves 1½ to 2½ inches; some very broad 1½ inches, many divided.
7	5.64	6.32	3.54	1.61	.30	9.43	36.9	1.62	50	Leaves old 2½ inches, many fragments.
8	6.75	6.05	3.49	1.61	.45	9.22	40.1	......	75	Large broad leaves, whole and divided.
9	8.42	7.29	3.08	1.38	.70	8.08	32.5	1.17	33	A few whole large old frayed leaves, but much dust; and 5 per cent. flower-buds.
10	6.82	4.98	2.49	1.22	.21	9.12	30.9	1.39	50	Fragments of large old leaves.
11	6.60	6.32	3.21	1.49	.34	12.00	39.9	1.28	75	Mostly whole, 1½ to 2½ inches.
12	7.90	6.04	3.32	1.55	.43	5.86	37.2	......	50	Large and woody; some appearing 3 inches long when the fragments are pieced.
W. 1	6.88	7.70	2.85	1.20	1.24	......	33.0	......	60	Leaves large and broad, mostly divided.
2	5.50	13.21	2.33	1.00	6.35	6.35	33.0	1.13	......	A few large leaves; but mostly dust, pebbles, and buds.
X. 1	7.24	6.47	3.12	1.39	.75	8.73	34.8	......	......	Leaves from 1½ inches upward; the larger divided.
2	6.40	6.17	3.20	1.45	.47	4.80	38.6	......	......	
Y. 1	7.62	6.23	2.75	1.18	.39	3.25	15.4	......	......	Fragments of large eroded leaves; many imperfectly rolled, and apparently exhausted and redried. In the statement given above of the average extractive of imperials, these three specimens were excluded.
2	6.65	6.00	3.25	1.54	.38	7.60	26.3	......	......	
3	6.96	6.51	2.90	1.45	.26	2.90	29.3	......	......	

HYSONS.

		Moisture.	Ash.	Soluble ash.	Alkalinity.	Silica.	Gum.	Extractive.	Theine.	Price per pound.	Remarks.
A.	1	6.40	6.71	4.06	1.71	.19	4.68	36.9	2.00	$1 00	Leaves cut transversely; medium in size.
	2	6.54	5.82	3.14	1.58	.41	9.63	33.4	1.25	50	Large whole leaves; some broad, coarse-veined, and old.
	3	5.58	6.56	....	....	.32	...	....	1.69	....	Leaves 1 to 1½ inches; many divided; some fragments and petioles.
	4	6.86	6.14	3.00	1.31	.32	4.18	34.3	....	75	Large and mostly whole.
	5	7.97	6.47	3.13	1.30	.69	10.53	34.7	1.52	30	Leaves very large, with wooded petioles and mid-veins.
	6	6.22	5.50	3.58	1.52	.53	....	40.4	....	40	Leaves elongated, divided, and many broken.
	7	5.90	6.67	...	....	1.00	....	4.30	....	50	
W.	1	7.18	5.94	3.33	1.62	.36	....	37.1	......	....	Leaves, large, divided, woody, and with eroded margins.
	2	7.20	6.37	......	......	.40	....	35.0	......	....	
	3	6.26	7.15	......	1.68	1.00	....	36.0	......	....	

JAPANS.

A.	1	6.00	6.17	3.87	1.70	.23	6.06	39.9	1.91	1 00	Leaves small and young, divided; many short-cut tender petioles.
	2	5.92	7.13	......	......	.60	....	....	1.35	50	Leaves small, fragments; old; compressed rather than rolled.
	3	7.90	5.57	3.34	1.43	.16	9.00	37.7	98	1 00	Leaves large and broken, many petioles, but tender.
	4	7.14	6.44	......	......	.60	12.30	37.0	......	50	All in small fragments; compressed.
	5	5.76	7.32	3.82	1.27	1.27	11.24	40.9	1.27	60	
W.	1	5.00	7.64	3.26	1.39	1.47	5.79	35.0	1.34	....	
(a)	1	2.86	7.00	2.78	1.40	1.20	12.50	35.0	1.17	....	Leaves, divided and broken; margins often eroded; petioles wiry. **Marked "*Good Common, $19 per picul.*"**
	2	2.70	7.24	2.80	1.40	1.26	11.10	37.9	1.07	....	As last, but less erosion. Marked "*Medium $23 per picul.*"
	3	2.82	6.68	2.92	1.40	1.04	10.00	40.0	1.25	....	As last, but some small and whole among them; the greater portion, however, still large, and often broad fragments with wiry petioles and mid-veins. Marked "*Good Medium $25 per picul.*"
	4	2.70	6.28	3.16	1.40	.64	10.50	42.0	1.47	....	Leaves 1½, but all broken or divided. Marked "*Fine $28 per picul.*"
	5	3.92	5.78	3.06	1.36	.52	10.00	41.2	1.70	....	Leaves generally about 1 inch; many tender petioles. Marked "*Finest $39 per picul.*"
	6	3.54	5.53	3.10	1 32	.46	14.80	43.9	1.70	....	Leaves generally about ¾ inch; many short cut petioles. Marked "*Choicest $43 per picul.*"

GROUND COFFEE.

Reliance was placed on the microscope for the detection of foreign vegetable substances in the ground coffee, and on the weight of the ash and silica for the discovery of mineral additions. The silica present in clean coffee is almost *nil*. The admixture of chicory increases the amount of this residue on account of the higher percentage which it contains; but the silica may be increased in the absence of vegetable adulterants by mineral matter accidentally present among the coffee-beans. Its presence naturally indicates that the coffee has been ground from a low-grade, carelessly-picked stock, as seems to have been the case in several of the samples in series W. Excluding such specimens, the average ash of the pure coffees tabulated below is 4.15 per cent., the extremes varying but little from this mean.

The specific gravity of a 10 per-cent. infusion, as suggested by Graham and others, was taken with the view of determining its reliability, as the experiment can be made more rapidly than a determination of the total extractive. The flask or covered beaker containing the coffee and water was immersed for an hour in the water-bath, which was kept boiling vigorously. The infusion was filtered, cooled to the proper temperature, and loss from evaporation made up by distilled water. The specific gravities obtained are rather lower than those recorded by Allen, due no doubt to a less perfect exhaustion than he effected. The amount of extractive corresponding to these specific gravities was ascertained and recorded. But it is believed that the thorough exhaustion of the coffee by means of successive waters and the estimation of the total extractive is a more satisfactory procedure than the method by density.

The soluble matters yielded by the unadulterated coffees averaged 21.2 per cent. Professor Parkes placed the yield at 30–35 per cent., and other writers make it equally high. The amount is said to depend on the degree of roasting. According to Hassall, Cadet states that coffee roasted to a red-brown color yields 12.3 per cent., chestnut-brown coffee 18.5 per cent., and dark brown 23.7 per cent. of extractive. This agrees with the results which are given below.

To establish the fact of adulteration in coffee, however, a simple inspection of the coffee-grounds after infusion is all that is needful. The coffee fragments retain a certain firmness of texture and darkness of color, while chicory, beans, and other vegetable matters become soft and whitish. These substances, as is well known, can also be separated by the rapidity of their fall when the coffee is thrown on the surface of a glass of cold water.

All the samples examined were loose coffees, with the exception of Z 1, which was in a one-pound packet.

GROUND COFFEES.

		Moisture.	Ash.	Silica.	Specific gravity.	Extractive.	Total extractive.	Remarks.
A	1	5.34	4.36	....	1007.2	17.8	......	Pure.
	2	5.26	4.70	....	1006.7	16.0	......	
	3	4.70	5.30	.....	1007.1	17.7	......	
	4	4.50	4.10	.....	1007.1	17.6	......	

GROUND COFFEES—*Continued.*

		Moisture.	Ash.	Silica.	Specific gravity.	Extractive.	Total extractive.	Remarks.
W	1	4.44	4.40	......	1006.5	15.6	......	Pure.
	2	4.23	4.06	.08	1007.3	17.3	21.8	
	3	3.80	4.12	.04	1006.8	16.7	20.0	
	4	4.50	4.00	.04	1006.7	16.0	20.3	
	5	5.52	4.16	.04	1006.7	16.0	20.0	
	6	7.44	4.32	.08	1007.2	17.2	20.3	
	7	4.74	4.78	.60	1006.3	15.1	20.7	
	8	6.14	5.74	1.24	1006.0	15.0	20.2	
	9	7.40	5.10	.66	1006.0	15.0	20.4	
	10	6.10	5.82	1.06	1006.8	16.8	20.8	
	11	5.54	6.00	1.64	1006.2	15.1	20.2	
	12	4.78	5.14	.74	1006.8	16.8	19.6	
X	1	7.56	4.36	.02	1006.6	16.0	20.3	
Y	1	4.74	4.34	.32	1007.4	18.5	22.2	
	2	5.50	4.14	.12	1007.3	17.5	22.0	
	3	4.00	4 00	.04	1006.6	16.1	21.8	
	4	6.	4.20	.16	1007.0	17.1	24.0	
	5	3.16	4.16	.06	1007.2	18.2	22.1	
	6	5.36	4.30	.62	1011.0	28.0	42.3	Chicory and beans.
	7	5.52	4.44	.46	1011.4	28.2	40.2	
	8	4.24	4.24	.06	1006.9	16.8	22.3	Pure.
	9	4.24	4.14	.04	1006.8	16.9	22.0	
	10	4.42	4.16	.08	1006.6	16.1	23.1	
	11	3.92	5.80	.34	1008.2	21.1	24.5	Small per cent chicory.
Z	1	......	1.80	.08	....	......	45.7	Chicory, corn, wheat, rye—anything but coffee.
C	1	5.64	4.02	.00	1007.2	17.3	20.7	Pure.

The last sample was also examined in the green or unroasted condition. The percentages were of moisture 8.80, ash 3.48, silica .00, and extractive 23.7. The coffee extracts and two chicories were purchased in Baltimore. Their examination resulted as follows:

	Ash.	Silica.	Extractive.	Vegetable refuse.	Remarks.
Z. Extract 1	4.50	.04	71.0	24.5	Chiefly masses of disorganized starches.
2	6.90	1.00	68.0	25.1	Fresh wheat and débris of roasted starches.
3	7.10	2.68	69.0	23.9	Chicory.
Z. Chicory 1	7.66	2.80	60.0	32.3	Pure.
1	11.00	3.20	51.0	38.0	Pure.

SUGARS.

In investigating the sugars a solution was made in order to note insoluble impurities. After standing for some time the sediment, if any, was transferred to the stage of the microscope for examination.

Most of the specimens showed the presence of accidental dust, such as may be found in the air of the grocery stores—starches of various kinds, tea and coffee particles, &c. But unless existing in quantity sufficient to impair the transparency of the solution, these could not be considered as detracting from the value of the sugar. The moisture in the sample was taken by drying 5 grams in an air-chamber for 12 or 15 hours at a temperature from 200° to 212° Fahrenheit. The ash was obtained by igniting 15 grams over a composite Bunsen flame. The last of the carbon is dissipated with difficulty, especially in dark-colored sugars, and the results are therefore only approximative; but the main object in reducing to an ash was the detection of tin or copper or of excessive quantities of iron or lime.

The detection of glucose or starch sugar is easily effected in the white sugars—the loaf, crushed, powdered, and granulated—as these contain so small a quantity of transformed cane sugar. The process adopted for the estimation of the glucose consisted of adding a weighed quantity of the sugar in solution to an excess of Fehling's solution heated to boiling on the water-bath. In a short time, when the reduction was accomplished, the blue liquid was poured off and the precipitate washed with boiling water by decantation. Filtration was seldom needful. The precipitate was then solved in ferric chloride with a little diluted sulphuric acid, cold water added in large quantity, and the estimation made by permanganate of potash. But the brown sugars contain naturally a certain percentage of sugar, which acts upon the copper solution. This percentage varies with the depth of color of the specimen. Experience, however, will soon enable one to pronounce from the color the amount of so-called grape-sugar which is normal to it, and any excess found by experiment suggests the presence of added glucose. In fact, any excess over 6 per cent. is suspicious, unless the sample is very dark. I regret that specimens of the Dutch standard were not available for the identification of the shades of the examined sugars. Even 6 per cent. may give grounds for suspicion in light-colored samples. Fortunately we have in the microscope a means for decision in uncertain cases. Microscopic masses of boiled starch cannot be accounted for in the sediment of the sugar solution, unless by assuming the incorporation of manufactured glucose with the sample. Any excess in the percentage of glucose found should therefore lead to a careful search for these tell-tale masses of disorganized starch. It has been stated as an argument against adulteration by glucose that the profit on the addition of small percentages would not pay for the expense of mixing, but several instances, such as W 1, Y 10, and Z 4 and 10, show conclusively that the mixing has been done. Where the glucose results are as high as in A 4 and 18, W 4, 5, 6, and 12, and Z 3 there is no need for corroboration of the microscope. Indeed such sugars may be recognized by simple inspection. They are characterized by their want of luster and by caking into masses which have a waxy fracture. It is probable that A 3 contains glucose, although the starch cells were not observed. This was one of the first specimens examined, and, as its color was very dark, the percentage of glucose was accepted as owing to the large quantity of molasses present; but, as subsequent experiments showed the glucose in the specimen to be higher than the average in sugars of its color, it is probable that a more careful microscopic examination might have detected the starch.

The samples marked *a* were presented by the Forest City Refinery, of Portland, Me.

LOAF SUGAR.

	Moisture.	Ash.	Grape sugar.	Remarks.
W 1	.10	.02	.010	Sediment *nil*.
2	.03	.00	.030	

CRUSHED SUGAR.

	Moisture.	Ash.	Grape sugar.	Remarks.
W 1	.20	.00	.04	Sediment *nil*.

POWDERED SUGAR.

	Moisture.	Ash.	Grape sugar.	Remarks.
A 1	.06	.00	.010	Accidental starch.
2	....	......	.062	*Nil.*
3	.12	.04	.062	Starch and cane fragments.
4	....	......	.020	Accidental dust and starch.
5	....	......	.055	*Nil.*
6	....	......	.017	
7	....	......	.017	Accidental corn-starch.
8	....	...	.096	*Nil.*
W 1	.27	.04	.010	Accidental dust, chiefly corn-starch.
2	.01	.01	.110	
3	.12	.04	.043	*Nil.*
4	.14	.04	.070	
5	.04	.00	.040	
6	.04	.00	.004	
7	.04	.00	.004	
8	.04	.00	.010	
9	.04	.00	.008	
10	.06	.00	.004	

GRANULATED SUGAR.

	Moisture.	Ash.	Grape sugar.	Remarks.
a 1	.04	.00	.078	*Nil.* Marked first quality.
2	.17	.04	.183	*Nil.* Marked second quality.
A 1	.20	.00	.060	*Nil.*
2	.00	.00	.120	Accidental dust.
3	.00	.00	.040	Dust and cane particles.
4	....	......	.030	Accidental dust.
5	....	......	.020	
6	....	......	.020	
7	....	......	.030	
8	....	......	.072	*Nil.*
9	....	......	.144	Accidental dust.
10	....	......	.038	
11	....	......	.036	*Nil.*
12	....	......	.017	
13	.06	.00	.104	
14	....	......	.130	
W 1	.03	.01	.050	Accidental dust.
2	.14	.02	.130	

STANDARD A SUGARS.

	Moisture.	Ash.	Grape sugar.	Remarks.
a 1	1.80	.00	.060	*Nil.* Marked Standard A.
2	2.40	.06	.261	*Nil.* Marked Falmouth A.
A 1	.36	.02	.520	Dust and cane particles.
2	.46	.20	.510	
3	.46	.32	.620	
4	.40	.12	.720	*Nil.*
5	1.52	.07	.375	
6	.36	.00	.130	
W 1	1.17	.20	.378	Dust.

STANDARD C SUGARS.

	Moisture.	Ash.	Grape sugar.	Remarks.
A 1	4.50	2.48	6.74	Dust, coffee, &c.
2	1.64	1.18	2.97	Cane, corn starch, and bone phosphate.
3	2.64	2.96	3.47	Accidental starches, &c.
4	3.64	.55	4.36	
5	.92	.80	2.82	Bone phosphate.
B 1	1.54	.44	2.06	Accidental dust.
2	3.30	.90	4.20	
3	2.64	1.40	4.00	
4	2.10	.60	2.32	

VARIOUS SUGARS.

	Moisture.	Ash.	Grape sugar.	Remarks.
A 1	3.70	1.32	7.32	Accidental dust .... Brown, 9 cents.
2	3.70	1.50	5.23	Brown, 10 cents.
3	4.14	1.92	9.10	Brown, 9 cents.
4	3.86	.60	20.00	Torula, disorganized starch cells and cane particles; N. P. B., 9½ cents.
5	.26	.06	.18	Accidental dust .... 2d A, 10¼ cents.
6	3.50	1.76	6.36	Ex. C, 9 cents.
7	1.34	1.08	1.54	.30 per cent. insoluble, of which .07 is organic and the rest bone phosphate. N. O., 9 cents.
8	2.22	1.12	3.43	Brown, 9 cents.
9	.88	.68	2.85	Dust.
10	4.30	2.40	6.61	*Nil*.............................. Brown, 9 cents.
11	.92	.38	3.10	Wheat starch and torula cells ......Brown, 9 cents.
12	4.24	3.38	8.15	Cane fragments, sand and acarus; D. B., 8½ cents.
13	4.30	1.86	6.48	Corn-starch.........................Brown, 9 cents.
14	2.84	1.78	6.40	Dust .... Brown, 9 cents.
15	2.66	.35	.85	*Nil*.................... Light Brown, 10 cents.
16	5.52	1.15	5.45	Dust.............................. Brown, 9 cents.
17	.40	.37	.46	*Nil*........................... N. O. Vac., 10 cents.
18	4.00	.30	14.00	Disorganized corn-starch and torula; brown, 10 cents, special.
19	3.88	.33	3.40	Dust.............................Brown, 10 cents.
20	4.26	1.25	3.35	*Nil.* ....Brown, 9 cents.
21	4.72	.42	4.71	*Nil*.......................... Brown, 10 cents.
22	4.76	1.13	4.00	Brown, 10 cents.
23	2.61	.25	1.49	Brown, 10 cents.
B 1	.60	1.24	1.56	*Nil.*
2	1.26	.52	3.50	
3	1.34	.74	2.60	
4	.90	.44	3.70	
C 1	1.68	.37	1.24	*Nil.*
E 1	3.80	.23	3.70	"Corn-stalk sugar." Made in Georgia.
2	2.73	.33	5.35	"Sorghum sugar."
W 1	5.00	.97	8.77	Masses of disorganized corn-starch.
2	5.82	.88	4.97	Accidental dust.
3	3.78	.48	3.32	
4	5.76	3.07	13.50	Boiled corn-starch.
5	4.88	.44	20.00	
6	5.16	.44	20.00	Corn-starch and acarus.
7	7.56	.66	5.60	Accidental dust.
8	4.30	.66	4.00	
9	6.10	.78	4.97	
10	2.76	.54	4.55	*Nil.*
11	3.96	1.04	5.00	.058 per cent. lime.
12	4.80	.74	18.50	Boiled corn-starch.
13	5.04	.32	3.20	*Nil.* .060 per cent. lime.
14	4.06	.90	3.12	Accidental flour.
X 1	1.44	1.04	2.52	*Nil.*
2	1.20	.44	1.94	Bone phosphate and vast numbers of acarus.
3	3.14	2.44	6.72	Accidental flour.

VARIOUS SUGARS—*Continued.*

		Moisture.	Ash.	Grape sugar.	Remarks.
Y	1	1.88	.43	2.70	
	2	3.56	.51	4.00	
	3	3.44	.58	3.50	
	4	3.20	.62	5.80	*Nil.*
	5	2.84	.75	4.30	
	6	4.36	.81	6.50	
	7	2.90	.60	3.60	
	8	3.92	.83	5.20	
	9	2.30	.50	4.30	*Nil.*
	10	4.64	1.45	10.00	Disorganized corn-starch.
Z	1	1.08	.66	5.00	Accidental dust.
	2	1.66	.45	2.50	*Nil.*
	3	3.90	1.07	31.00	Disorganized wheat-flour.
	4	3.44	1.50	11.50	
	5	1.24	1.05	3.40	
	6	2.44	.90	6.00	Accidental dust, wheat-starch, and black pepper.
	7	2.60	1.30	6.70	
	8	2.66	1.32	6.40	
	9	2.36	1.02	6.20	*Nil.*
	10	2.30	1.30	8.40	Disorganized corn-starch.

SIRUPS.

The moisture, ash, and glucose were obtained as in the case of the sugars. On account of the large quantity of reducing sugar naturally present in sirup and molasses it would be a difficult matter to detect the presence of a small addition of glucose solution unless the disorganized starch corpuscles were discovered on microscopic examination. But any large addition would manifest its presence by the unusual quantity of reducing sugar found by experiment.

To ascertain the quantity of so-called grape sugar naturally present in the sirups, four samples B were obtained from refiners by the Commissary-General of Subsistence, United States Army. The specimens furnished by Washington dealers were also viewed as representing the ordinary character of unadulterated sirups, since it was unlikely that any which were known to contain manufactured glucose would be sent in for analysis. These gave varying percentages up to 29.60, while the largest figure obtained from any of the examined sirups was only 35.30 per cent. Taken in conjunction with their freedom from starch corpuscles, it seems clear that in none was there any addition of manufactured glucose. The results correspond with those obtained by Wallace from the products of a Greenock sugar refinery. His analyses, as quoted by Hassall, are:

	Moisture.	Ash.	Grape sugar.	Coloring and extractive.	Cane sugar.
Golden sirup	22.7	2.5	33.00	2.8	39.6
Molasses	31.1	1.4	18.00	1.5	48.0
Treacle	23.4	3.5	37.20	3.5	32.5

The following analyses are so much at variance with Professor Kedzie's results, recorded in the Michigan State board of health report for 1874, that it is difficult to reconcile them except on the assumption that at that time the market was stocked with a manufactured article which failed to please the public taste and has since disappeared. His specimens, which were all obtained from first-class grocers, are offset in the following list by twenty-one samples from first-class sources and twelve from the lowest grade stores which could be found in Washington City:

SIRUPS.

		Marks.	Price.	Moisture.	Ash.	Grape-sugar.	Remarks.
			Cents.				
A	1	Molasses....	40	21.00	3.48	25.90	
	2	.... do......	60	16.36	.84	22.30	Sediment. *Nil.*
	3	.... do......	50	17.20	1.30	23.12	
	4	.... do......	50	28.71	2.55	12.26	Torula cells.
	5	Black strap.	30	26.82	4.21	25.70	
	6	Porto Rico..	75	25.23	1.04	19.24	
	7	Sirup......	60	26.04	4.45	16.10	
	8	.... do......	......	21.00	.70	22.30	
	9	Golden sirup	60	19.33	3.90	23.57	
	10	.... do......	60	22.61	.53	21.10	
	11	.... do......	60	23.21	2.22	26.71	*Nil.*
	12	.... do......	60	21.05	1.92	29.60	
	13	Drip sirup..	75	18.51	3.45	26.00	
	14	.... do......	60	17.30	3.72	26.16	
	15	.... do......	80	17.17	2.03	29.00	
	16	.... do......	75	18.00	3.18	29.60	
B	1	Sirup.......	......	17.83	4.40	29.00	*Nil.*
	2	.... do......	......	22.22	4.50	21.25	Lime, .112 per cent. *Nil.*
	3	.... do......	......	24.90	3.49	21.40	*Nil.*
	4	.... do......	......	19.10	3.40	20.42	*Nil.*

SIRUPS—*Continued.*

		Marks.	Price.	Moisture.	Ash.	Grape-sugar.	Remarks.
			Cents.				
C	1	Molasses....	......	19.00	4.72	21.00	
W	1	.... do......	......	22.00	4.60	26.40	Nil.
	2	.... do......	......	27.00	3.89	30.00	
	3	Sirup.......	......	27.00	2.38	17.00	Torula cells.
	4	.... do......	......	16.00	.98	26.00	*Nil.*
	5	.... do......	......	22.00	1.05	33.00	Lime, .187 per cent. *Nil.*
	6	.... do......	......	26.00	2.25	31.40	Lime, .056 per cent *Nil.*
	7	.... do......	......	26.20	3.30	35.30	Lime, .19 per cent. *Nil.*
	8	.... do......	......	27.80	1.66	35.10	*Nil.*
	9	.... do......	......	21.30	.90	33.10	*Nil.*
	10	Muscovado...	......	28.00	2.65	11.63	Bacteria, bacilli, and torula.
	11	Porto Rico..	......	20.00	3.53	27.20	Lime, .07 per cent.
	12	Golden sirup	......	17.00	.92	29.00	Bacteria.

FLOUR.

The moisture was taken by drying in the air-chamber, and the gluten by washing and drying as ordinarily practiced. These estimations have a reference more to quality than impurity. The average moisture is 11.09 per cent., the maximum being 12.80 and the minimum 8.20.

The gluten varies considerably, from 7.40 in B 18 to 17.50 in B 23. The samples represent the production of all parts of the country, those in series B having been obtained from military depots and posts through the kindness of the Commissary-General of the Army. They embrace winter and spring wheats, the strongest flour produced by high milling, straight flours by the same process and those produced by mixing deteriorated flours with a highly glutinous stock so as to render them saleable and useful. Hence the variation in the quantity of gluten. It may be stated from the experience gained in gathering these percentages that the flour is inferior when the gluten is under 10 per cent., of good marketable character when from 10 to 12, and of high grade when over 12 per cent.

An inspection of the figures of the ash shows the absence of mineral additions. Alum was proved to be absent by the use of the logwood and carbonate of ammonia test, but in cases where the ash was comparatively high the silica was separated and the phosphate of alumina thrown down from 100 grams and weighed. The average ash is .525 per cent.

The microscopic examination proved the freedom of the samples from foreign flours and fungous growths. B 27 contained a small quantity of comparatively coarsely ground corn. This was first detected as minute horny particles in washing out the gluten. When their presence was known they could be discovered by the fingers in the dry flour. Their nature was demonstrated by the microscope. As they occurred in but small quantity and in an otherwise superior flour, their presence must be considered accidental. An effort was made to discover the method of their introduction, but without success. The miller who ground the flour insisted that the particles must be sand which had insinuated itself through the meshes of the sacks from an unswept railway car into which they had been packed for transportation. On reporting the analysis of B 18 it was ascertained that this flour had been tested practically by a board of Army officers and condemned as unfit for bread-making.

The only noteworthy point developed by the microscopic examination is that the starch granules of superior samples did not scatter so freely over the field, but remained bound up by the cellulose into globular and cylindrical masses.

FLOURS.

		Moisture.	Ash.	Gluten.	Remarks.
A	1	10.80	.44	15.78	
	2	11.92	.50	10.90	
B	1	11.84	.52	13.24	
	2	11.60	.48	11.16	
	3	12.14	.44	14.50	
	4	11.80	.54	15.80	
	5	11.80	.60	13.26	
	6	11.18	.44	14.14	
	7	12.26	.66	10.06	
	8	11.54	.50	14.16	
	9	11.56	.70	15.64	Silica, .008 per cent.; phos. alumina, .005 per cent
	10	8.80	.50	9.68	
	11	8.20	.56	16.30	
	12	11.46	.36	10.68	
	13	11.22	.42	10.62	
	14	10.92	.42	10.24	
	15	10.74	.58	9.98	
	16	8.96	.60	10.54	
	17	10.88	.60	10.90	
	18	9.96	.54	7.40	
	19	9.52	.54	11.34	
	20	10.72	.60	8.34	

FLOURS—*Continued*

	Moisture.	Ash.	Gluten.	Remarks.
21	10.38	.70	8.70	Silica, .006 per cent.; phos. alumina, .005 per cent.
22	10.82	.46	10.78	
23	10.50	.60	17.50	
24	10.46	.60	10.12	
25	10.56	.46	13.70	
26	11.30	.60	13.04	
27	10.44	.50	14.30	
1	11.22	.50	13.66	
1	11.10	.56	10.76	
2	11.76	.38	10.60	
3	10.96	.52	11.54	
4	10.00	.56	10.98	
5	11.10	.48	14.46	
6	10.96	.48	11.14	
7	10.80	.50	12.30	
8	12.30	.54	11.72	
9	12.08	.60	13.08	
10	12.20	.52	9.72	
11	9.66	.56	11.88	
12	11.10	.46	10.66	
13	11.90	.46	10.76	
14	11.92	.50	11.12	
15	11.10	.46	10.72	
16	10.00	.50	13.62	
17	12.02	.40	11.80	
18	11.60	.46	13.08	
19	11.28	.40	9.74	
20	9.54	.62	11.20	
21	9.58	.44	9.94	
1	12.20	.60	9.34	
2	12.66	.56	6.84	
1	12.80	.50	11.60	
2	12.20	.78	8.40	Silica, .027 per cent.; alum. phosph., .006 per cent.
3	12.00	.58	9.50	
4	10.76	.54	12.66	
5	11.96	.54	11.96	

CORN-MEAL.

The moisture, ash, and microscopic appearances of these samples ve satisfactory proof of their freedom from impurities.

	Moisture.	Ash.	Remarks.
A 1	11.04	1.24	
2	10.49	1.28	
B 1	11.16	1.18	
2	10.92	1.34	
W 1	10.66	1.20	
2	11.54	1.20	
3	10.14	1.30	
4	10.34	1.32	
5	10.36	1.20	
6	11.14	1.24	All free from foreign admixture.
7	11.46	1.16	
8	12.00	1.16	
9	10.06	1.20	
10	11.06	1.24	
11	10.87	1.20	
12	11.50	1.16	
13	10.80	1.28	
14	10.80	1.28	
15	10.16	1.24	
16	10.64	1.32	
verage	10.85	1.24	

LARD.

A quantity varying from 12 to 20 grams was dried in the air-chamr and ignited. The results were so satisfactory that there seemed to no necessity for adding to the number of samples.

	Ash.	Water.	Remarks.
W 1	.030	.03	
2	.060	.21	
3	.000	.08	
4	.070	.07	
5	.020	.25	
6	.010	.14	
7	.010	.16	
8	.050	.15	No starch or other adulterant by the microscope.
9	.020	.14	
10	.030	.10	
11	.025	.15	
12	.030	.00	
13	.013	.00	
14	.030	.01	
verage.	.028	.107	

BREAD.

The breads were examined by the processes which were used in the case of the flours. They were all apparently of good quality, white, evenly vacuoled, and free from doughy streaks. They were fresh at the time of the examination, but thoroughly cold. The crumb only was used. W 8 contains an excess of water and quite a number have so much phosphate of alumina that the addition of alum is a certainty. J. Carter Bell in the *Analyst* for July, 1879, gives a series of illustrative cases showing that alumina may be present accidentally in flour and bread to a larger extent than is usually supposed, but that in such cases the proportion of the accompanying silica is also large, so that practically no difficulty is experienced in dealing with them. Those specimens in the following table which have a high phosphate of alumina do not have the silica correspondingly increased. The ash shows, as in the flour samples, that mineral powders are not used as adulterants. Copper was not detected in any of the specimens.

	Moisture.	Ash.	Silica.	Phosphate of Iron.	Phosphate of Alumina.	Remarks.
W 1	6.34	1.06	.024	.0015	.009	Cream biscuits.
2	7.20	1.10	.024	.0013	.005	Soda biscuits.
3	30.80	.70	.052	.0013	.007	Rolls.
4	38.92	1.20	.036	.0027	.005	Loaf.
5	42.00	1.04	.012	.0013	.019	Do.
6	40.20	1.00	.012	.0009	.009	Do.
7	42.22	1.00	.020	.0015	.027	Do.
8	53.90	1.02	.016	.0027	.043	Do.
9	43.20	1.10	.015	.0009	.020	Do.
10	41.90	1.14	.009	.0013	.007	Do.
11	40.80	1.28	.015	.0009	.007	Do.
12	42.60	1.24	.024	.0007	.005	Do.
13	40.76	1.28	.016	.0015	.036	Do.
14	43.00	.96	.040	.0007	.006	Do.
15	40.80	1.08	.012	.0013	.020	Do.
16	42.74	1.24	.015	.0013	.030	Do.
17	45.70	1.08	.010	.0006	.005	Do.
18	43.90	.98	.010	.0027	.019	Do.
C 1	7.56	.58	.020	.0013	.005	Hard bread.

BICARBONATE OF SODA.

These samples were tested qualitatively for the presence of sulphur salts, chlorides, and sulphates. For the technical estimation of their value the weight of the ignited salt, its alkalinity, and the total of carbonic acid in the unignited specimen were considered necessary. Pure bicarbonate yields 63.1 per cent. of residue, and when the alkalinity is calculated into carbonate of soda the same figures should be obtained. Other results must of necessity be owing to impurity. Thus in W 1 the residue weighed 69.1, with an alkalinity showing 64.9 of carbonate of soda. There was therefore present 4.2 per cent. of mineral impurities, chiefly chlorides and sulphates. Again, pure bicarbonate contains 52.4 per cent. of carbonic acid. Any deficiency found in a particular case corresponds with non-carbonated impurity or with the presence of mono-carbonate from careless manufacture or preservation. But as the former has already been obtained the latter can be calculated. The carbonic acid of the ash is deducted from the total carbonic acid for one-half of the amount existing as bicarbonate. The whole of the amount thus existing when deducted from the total gives that present as carbonate.

	Residue.	Alkalinity of residue.	Total carbonic acid.		Pure bi-carb.	Carbonate.	Saline impurities.
A 1	64.9	63.6	49.2	=	87.0	8.7	1.3
W 1	69.1	64.9	43.3	=	62.6	25.3	4.2
2	65.1	61.7	47.6	=	84.0	8.7	3.4
3	63.5	60.8	47.0	=	83.2	8.2	2.7
4	64.3	62.0	50.6	=	94.3	2.4	2.3
5	63.6	61.3	51.2	=	97.0	0.0	2.3
6	65.4	61.8	48.6	=	87.8	6.4	3.6
7	67.2	58.3	47.7	=	89.7	1.7	8.9
8	64.5	62.1	50.6	=	94.7	2.4	2.4
9	64.3	62.1	50.8	=	95.5	1.9	2.2
10	67.6	57.5	47.1	=	88.6	1.7	10.1
11	65.6	62.5	48.3	=	89.0	4.1	2.6

BAKING-POWDERS.

In a baking-powder which, according to the qualitative analysis, consists of alum, bicarbonate, and starch, estimations of the alumina of the starch and of the excess, if any, of bicarbonate give all the data necessary to calculate its composition. In the case given below the carbonic and sulphuric acids were estimated to corroborate results.

In those whose essentials are bicarbonate and acid phosphate of lime, alumina, chlorine, and sulphuric acid may be discovered as impurities in the materials, the sulphates forming a considerable percentage. The lime, phosphoric and sulphuric acids were determined and the bicarbonate calculated from the chloride of sodium obtained from it, deduction being made for sodium salts existing as impurities.

In a third class of cases a mixture of alum and acid phosphate is found. With either of these acid salts carbonic acid is evolved from bicarbonate, each molecule of alum setting free six of carbonic acid by means of its sulphuric acid, each molecule of phosphoric acid in excess of that rendered neutral by the lime acting in the same manner. But when the two are combined in one powder an interference takes place, and phosphoric acid falls with the alumina as insoluble phosphate without acting upon the bicarbonate. As alum is accused, and no doubt correctly, of precipitating the phosphates of the flour, the addition of the acid phosphate to the alum in these powders is probably intended to prevent this deterioration.

In powders which were proved by qualitative examination to consist of cream of tartar and bicarbonate the excess of alkalinity was taken in the solution after thorough decomposition was accomplished, and was calculated into the bicarbonate existing in excess. The alkalinity of the ash with this excess deducted from it was a measure of the bicarbonate and pure cream of tartar present and of the carbonic acid evolved during decomposition. Starch had to be separated and weighed. The weight of the ignited powder afforded a check on the calculations. The cream of tartar in all the samples contained the proportion of lime tartrate usual in the commercial article. Some of the powders contained minute particles of woody tissue, which to the eye were suggestive of the presence of malt as a constituent, but the microscope developed their true character, while the absence of sugar by Fehling's solution gave chemical evidence of the non-existence of malt in the sample.

No tartaric-acid powders were presented for examination.

	Bicarb. soda.	Bicarb. in excess.	Bitartrate.	Bitart. in excess.	Cryst. alum.	Lime sulphate.	Phosphoric acid existing as acid phosphate lime.	Starch.	Gum.	P. c. carbonic acid evolved.	Remarks.
W 1	26.6	....	....	....	48.0	....	...	51.9	...	13.9	
2	10.2	4.0	....	....	18.5	5.1	3.4	45.3	....	5.3	
3	10.2	4.0	....	....	18.5	1.0	3.4	38.5	....	5.3	Corn-starch.
4	14.7	7.6	....	....	25.9	....	5.5	46.2	....	7.7	
5	9.4	4.0	....	....	17.6	3.0	3.1	49.6	...	5.1	
6	31.0	...	..	....	....	10.9	19.3	22.0	....	16.0	
B 1	23.1	1.7	51.7	....	....	....	....	....	29.0	12.1	Spiral vessels, dotted ducts, &c., from impurities in the gum.
2	24.3	4.2	54.5	....	....	....	....	13.4	....	12.7	Wheat-starch.
3	7.8	....	17.4	4.4	....	...	....	55.5	....	4.1	Corn and wheat starches and woody tissue, suggesting malt.
4	21.4	4.7	47.9	....	....	....	....	12.6	....	11.2	Corn-starch.
5	15.2	1.5	34.1	....	....	....	....	36.2	..	8.0	Wheat and corn starch.
6	19.5	6.3	43.7	....	....	....	....	23.1	...	10.2	
7	26.8	1.8	60.2	....	....	....	....	6.0	....	14.1	
8	17.1	3.8	38.3	....	....	....	....	30.6	....	8.9	Corn-starch.
9	18.1	1.3	40.6	....	....	....	....	26.0	....	9.5	
10	18.2	2.3	40.8	....	....	....	....	31.2	....	9.5	
11	17.7	.	39.7	....	....	....	....	27.4	....	9.3	Corn-starch and wheat-flour.
12	16.8	5.9	37.7	....	....	....	....	29.2	...	8.8	Corn-starch.

CREAM OF TARTAR.

In the case of cream of tartar of ordinary commercial purity the alkalinity of the ash gives the percentage of pure bitartrate present, while that of the accompanying lime tartrate may be deduced from an estimation of the lime. If terra alba has been added the sulphuric acid must also be determined. If an acid sulphate as of soda or potash is present the case becomes complicated, but it is probable that a comparison of the free acidity before ignition with the alkalinity existing after it would give valuable information concerning the percentages. In the case of a pure bitartrate the carbonate in the ash corresponds to the acidity of the sample, but in the presence of an acid sulphate the alkalinity of the ash would be diminished or perhaps destroyed. The precipitation of the acid as a baryta salt and its existence in excess of the lime would corroborate the result. A thorough examination of some of these adulterated samples involves a good deal of time and labor, and an accurate expression of the percentage of the pure article is sometimes only to be obtained with difficulty, but it seems as if all practical purposes would be effected by a simple determination of the lime or sulphuric acid, as neither terra alba, alum, acid phosphate of lime, nor the acid sulphates of the alkalies can be present without giving percentages of one or other of those substances sufficient to detect adulteration and give expression to its amount. Starch can be discovered by iodine or the microscope.

	Bitartrate of potash.	Tartrate of lime.	Sulphate of lime.	Alum as crystallized.	Phosphoric acid in phosphate.	Starch.	Remarks.
A 1	87	8	......	......	......	......	
W 1	......	......	50	19	20	......	Ammonia alum.
2	84	8	......	......	......	......	
3	26	......	70	......	......	......	
4	9	......	90	......	......	......	
5	9	......	88	......	......	......	
6	......	......	......	20	21	39	Potato-starch and ammonia alum.
7	25	......	65	......	......	......	
8	34	......	53	......	......	......	
9	24	......	37	......	......	38	Corn-starch.
10	65	5	17	......	......	......	
11	83	13	......	......	......	......	
12	90	7	......	......	......	......	Traces of sulphates and chlorides.
13	83	11	......	......	......	......	
Y 1	73	......	20	......	......	......	
2	84	11	......	......	......	......	
3	75	......	24	......	......	......	
4	10	......	90	......	......	......	

GROUND BLACK PEPPERS.

In the examination of the peppers the moisture was determined together with the ash and silicious residue. The average ash of the pure article is 4.17 per cent., of which about one-tenth or .42 per cent. of the pepper is insoluble in hydrochloric acid. Where foreign starches have been added the ash is diminished, unless, which is generally the case, there has been at the same time an admixture of mineral matter from the use of inferior and uncleaned pepper-corns. The extraneous mineral substances consist of sand and clay, and in a few cases such as W 2 and Z 7 the quantity is so large as to suggest their intentional addition for the gain in weight. The alcoholic extractive, consisting of piperine and resin, is not of much value in determining purity. It affords a means for estimating the relative value of pure samples; but in adulterated cases it is evident that mustard husks or linseed cake might give a large oily residue. The separation and estimation of the piperine would probably enable an approximative estimate of the percentage of adulteration to be made, but the object in view in these analyses did not require this. In fact the amount and character of the ash and the microscopic appearances are sufficient for the detection of adulteration.

All the samples consisted of loose pepper, except those B furnished by the Commissary-General, which were in quarter-pound cans, most of them having fancy labels bearing guarantees of purity. W 8 was put up in 1-ounce packages bearing the name of the mills where they were manufactured.

	Moisture.	Ash.	Sand, &c.	Alcoholic extract.	Remarks.
A 1..	10.64	5.30	2.00	6.38	10 per cent. baked flour.
2..	11.10	4.44	.68	5.72	Pure, 40 cents per pound.
3..	11.28	3.38	.64	5.32	Large per cent. rice; 30 cents per pound.
4..	10.92	6.44	2.94	7.50	Baked flour and sand.
B 1..	11.80	4.40	.40	7.26	Pure.
2..	11.44	6.40	1.88	7.42	Pure, but too much sand.
3..	10.70	4.00	.48	6.00	
4..	10.90	3.80	.30	5.70	
5..	12.70	4.10	.44	5.40	Pure.
6..	10.80	3.90	.12	7.00	
7..	11.90	3.76	.30	6.70	
8..	13.08	7.44	2.66	5.76	
9..	12.88	7.06	2.32	6.00	Pure, but for the sand.
10..	12.94	7.34	2.60	6.30	
11..	12.90	7.60	2.70	6.00	
12..	12.90	4.90	.68	7.80	Pure.
13..	11.78	4.10	.42	7.20	
14..	11.40	4.38	.48	6.90	Contains a few starch cells, apparently from ginger and probably accidental.
15..	12.64	5.26	1.58	6.00	Fresh wheat-flour 10 to 15 per cent.
16..	10.90	4.00	.62	5.20	Large percentage baked wheat-flour.
W 1..	9.80	5.22	1.52	6.20	Large percentage rice, some wheat, and mustard husks. Extractive oily.
2..	9.28	9.34	4.26	6.14	Rice, mustard, and sand.
3..	10.12	4.00	.76	6.22	
4..	9.00	3.62	.70	5.64	Roasted wheat.
5..	7.76	4.00	1.16	4.90	
6..	7.62	7.68	3.00	6.88	Pure, but for the sand.
7..	8.18	5.82	.62	5.50	Roasted wheat.
8..	9.74	4.08	.92	3.80	Fresh and baked starches, wheat, corn, and beans.
9..	9.30	3.96	.40	5.50	Pure.
10..	8.08	3.44	.54	5.50	Rice, corn, and wheat.
11..	12.66	3.98	.84	6.36	Large percentage corn-flour.
12..	12.36	4.40	.60	6.24	Small percentage corn-flour.
13..	11.64	3.40	.42	3.80	Chiefly baked wheat.
14..	12.14	6.96	1.86	6.00	Pure, but for the sand.

GROUND BLACK PEPPERS—*Continued.*

	Moisture.	Ash.	Sand, &c.	Alcoholic extract.	Remarks.
Y 1..	9.00	5.84	1.37	4.38	Rice and roasted wheat.
2..	8.50	3.94	.66	5.74	
3..	10.86	6.84	1.94	4.60	Rice.
4..	9.84	7.80	3.60	6.44	Sand and rice.
5..	9.66	4.20	.86	5.72	Rice, corn, cayenne, and turmeric.
6..	9.16	4.50	1.34	4.46	Roasted wheat and turmeric.
7..	10.74	6.48	1.92	6.60	Pure but for sand.
8..	8.24	2.94	.40	2.90	Rice, roasted wheat, and turmeric.
9..	10.76	9.44	3.72	5.84	Roasted wheat.
10..	8.64	5.20	1.72	5.68	Rice and roasted wheat.
11..	8.44	6.12	.56	5.60	Roasted wheat.
Z 1..	8.50	5.14	2.50	3.38	Roasted wheat and corn.
2..	9.60	6.72	1.74	6.78	Pure, but too much sand.
3..	12.14	5.94	2.00	6.38	Rice and sand.
4..	8.64	3.94	1.10	7.68	Rice and linseed husks.
5..	10.80	5.14	1.12	4.40	Corn-flour.
6..	8.92	5.24	1.12	4.20	Wheat, beans, and rice.
7..	9.30	8.34	5.24	7.34	Sand, small percentage wheat, and mustard.

Only one sample of white pepper was obtained. It was furnished by the dealer who sent in A 2 in the above list, and was marked 50 cents per pound. It was free from all extraneous matters and gave 11.08 percentage of moisture, 1.24 ash, .38 sand, and 7.28 extractive.

GROUND ALLSPICE.

In determining the purity of ground allspice reliance was placed on the microscope for the detection of foreign vegetable matters, and on the ash for the discovery of mineral adulterations. A sample of clean whole allspice gave 3.92 per cent. of ash, with no sand or clay. The samples furnished by the Commissary-General were in ½-pound cans; the others were in bulk with the exception of W 1, which were put up in half-ounce packets.

	Ash.	Sand.	Microscopic characters, &c.
A 1..	3.86	.16	Pure.
2..	5.62	.46	
B 1..	5.24	.12	Pure.
2..	4.52	.18	
3..	4.98	.18	
W 1..	3.86	.04	Large percentage of foreign starches.
2..	6.90	2.26	Pure, but for the sand.
3..	3.84	.12	Pure.
4..	6.50	1.00	Large percentage corn-starch.
5..	5.02	.01	Pure.
6..	5.48	.04	
7..	5.28	.12	
8..	4.78	.20	
9..	5.04	.04	
Y 1..	4.20	.34	
2..	3.60	.18	
3..	5.64	.54	
4..	4.90	.48	Bread crusts.
5..	7.12	1.04	Roasted beans, wheat, and turmeric.
6..	4.94	.44	Bread crusts.
7..	5.96	1.66	Small percentage beans.
8..	6.54	.64	Small percentage cloves and allspice, and much unknown woody tissues.
Z 1..	3.94	.16	Pure.
2..	5.80	.60	
3..	4.36	.36	Large percentage corn-starch.
4..	6.40	1.04	
5..	4.90	.72	
6..	4.40	.42	Bread crusts chiefly.

GROUND GINGER.

In the case of ginger also the ash and microscope were relied upon for the detection of impurities. The samples of the Subsistence Department were in cans obtained direct from the manufacturers; the others were in bulk.

	Ash.	Sand, &c.	Remarks.
A 1	5.34	1.48	Pure.
B 1	7.28	3.08	Pure, but No. 1 has by far too much sand.
2	5.16	1.38	
3	4.80	.84	
4	4.90	1.00	
5	4.68	.90	
W 1	3.14	.30	Bran of wheat, husks of black pepper, turmeric, and a little ginger.
2	2.48	.42	Mostly corn-starch.
3	6.46	2.43	Pure, but for the sand.
4	10.16	5.24	Ground rice and sand.
5	6.72	1.60	Wheat-flour.
6	3.30	.70	Corn-starch.
7	6.90	2.36	Sand and clay.
8	4.22	.74	Pure.
9	5.94	1.82	Pure, but sand too high.
10	4.48	.64	Pure.
Z 1	4.58	.76	Pure.

GROUND NUTMEGS.

Only one specimen of powdered nutmeg was sent for examination. It came from Nashville, Tennessee, and was in a half-ounce packet with a fancy label. It gave 2.80 per cent. of ash and .04 of sand. Under the microscope it was found to be mixed with a considerable quantity of wheat-starch.

GROUND MACE.

A few samples of ground mace were obtained. The letters indicate their origin. Very little mace was discoverable in the purchased specimens.

	Ash.	Sand.	Remarks.
A 1	2.72	.40	Turmeric and wheat-starch.
2	1.80	.06	Pure.
3	1.74	.06	Pure.
W 1	2.00	.08	Wheat-starch, rice, and turmeric.
Y 1	3.18	.48	Corn, wheat, and turmeric.
2	3.18	.76	Allspice and turmeric.
3	5.20	.22	Roasted beans, wheat, corn, and turmeric.
4	2.38	.36	Rice, allspice, wheat-bran, and turmeric.
5	2.24	.32	Corn-flour, and turmeric.
6	2.44	.24	Corn and wheat-flour and turmeric.
7	3.36	.56	Corn-flour and turmeric.

CLOVES.

Five samples of whole cloves, purchased in Washington, D. C., were found to be sound and good. Without being picked or cleaned they gave the following results:

	Ash.	Sand.
W 1	6.46	.12
2	5.80	.20
3	6.20	.18
4	6.24	.12
5	6.04	.30
Average	6.15	.18

Manganese was very noticeable as a constituent of the ash of some of these specimens, as well as of those which follow.

GROUND CLOVES.

Most of these were examined for metallic impurities; but, as is evident from a superficial inspection of the two columns of figures below, the extraneous mineral matters in every case except W 7 consisted of the sand and clay adhering to the uncleaned buds and the vegetable products fraudulently mixed with them. Lime sulphate constituted the small excess in the exceptional case.

	Ash.	Sand, &c.	Remarks.
A 1	7.02	.58	Pure.
2	6.24	.38	
B 1	7.30	1.36	Pure.
2	5.40	.28	
W 1	6.48	.30	Pure.
2	7.56	1.04	
3	7.88	2.14	Allspice.
4	7.18	.88	Small per cent. allspice.
5	7.24	1.40	
6	5.76	.58	Large per cent. allspice.
7	8.74	.82	
Y 1	7.76	2.50	Roasted corn, wheat, beans, and sand.
2	7.50	1.62	Beans.
3	6.44	.80	Allspice and beans.
4	4.90	.86	Allspice and beans.
5	5.74	.90	Allspice.
6	4.60	.26	Beans and wheat.
7	6.74	.44	Allspice and beans.
Z 1	6.46	.94	Bread-crusts.
2	6.10	.64	Allspice.
3	8.10	1.68	Small per cent. allspice.
4	8.00	1.44	Roasted corn and allspice.
5	7.72	1.28	Pure.
6	7.30	.94	Allspice and corn.

WHOLE CINNAMON.

One sample was obtained by purchase in Washington, D. C. It presented the general and microscopic characters of cassia, and gave 2.68 per cent. of ash and .06 of sand.

GROUND CASSIA.

Two samples in unbroken cans were furnished by the Commissary General, United States Army. They gave the following results:

	Ash.	Sand.	Remarks.
B. 1	4.77	.00	Pure.
2	5.44	.00	Contains wheat-starch.

menced in Havana and have been renewed in New Orleans. These researches include an investigation upon organized particles from swamps and other malarious localities, with the view of testing the accuracy of the observations of Klebs and Tomassi-Crudeli, and others, on the existence of spores alleged to be the producing cause of malarial fevers. (Appendix I.)

XIV. A report by Dr. J. J. Woodward, U. S. A., on the Pathological Histology of Yellow Fever, is hereto annexed, marked K.

XV. A report by Professor Abbe, of the Signal Service Bureau, on the possible relations between meteorological phenomena and vital statistics, and especially on the graphical methods of representing such data, which report, with the accompanying illustrative diagrams and charts, will be found in Appendix L.

XVI. An investigation by Col. G. E. Waring, jr., of Newport, R. I., on the influence of the water-seal of traps of different kinds of currents of water passing through them or through the pipes into which they deliver, under a variety of conditions, covering ventilation, copious or partial, and induced currents arising from the passage of water over the branches of different form and arrangement, including experiments with regard to siphoning and the best manner to secure an adequate flush for water-closets, drains, &c.

XVII. An investigation by Prof. Ira Remsen, of the Johns Hopkins University, Baltimore, as to the amount of carbonic oxide in furnace-heated rooms.

XVIII. An investigation under the direction and supervision of Prof. J. W. Mallet, of the University of Virginia, on the best method of determining the amount of organic matter in potable water, and its effect on the health of persons who drink such water. This work will involve the co-operation of three distinct analysts, each employing a different method from the rest.

XIX. The history of quarantine in the United States, exhibiting the occasions which give rise to quarantine legislation, or attempts at such legislation by States or by the general government, prepared by Dr. Stephen Smith, a member of the Board.

SANITARY SURVEYS.

The following sanitary surveys have been conducted under the auspices of the board:

I. A sanitary survey of the eastern coast of New Jersey bordering on New York Harbor, carried on with the aid of this board, under the direction of the State Board of Health of New Jersey.

II. A sanitary survey of the City of Memphis, Tennessee, under the direction of a special committee of this board, of which Dr. J. S. Billings was the chairman. The final report of this committee, marked M, is hereto appended. In connection with this survey Dr. Charles Smart, U. S. A., has furnished a full report on the condition of the water supply of Memphis, and also of certain smaller towns in Mississippi, which is appended to the report on the sanitary survey.

III. A report by Dr. Charles Smart on the water supply of Mobile and New Orleans. (See Appendix N.)

IV. A sanitary survey of selected portions of Baltimore City was undertaken by this board, in compliance with the request of the city council, and Dr. C. W. Chancellor, secretary of the State Board of Health, was appointed a special sanitary inspector to conduct the work. His report and the correspondence which preceded and followed the work are appended hereto, marked O.

VITAL STATISTICS AND NOMENCLATURE OF DISEASES.

In the quarterly report of this board for the quarter ending June 30, 1880, reference was made to a conference held in Washington on the 6th and 7th of May, to which the registrars of vital statistics of the different States and municipalities, and all persons interested in the subject, had been invited The report of the proceedings of the conference, as published in Supplement No. 5 to the BULLETIN, was appended to the said quarterly report. At a subsequent date the committee appointed by the conference to consider the best method of tabulating mortality statistics made a report on that subject, a copy of which is hereto annexed, marked P.

The same committee having been charged with the duty of conferring with the committee of the Royal College of Physicians in London, engaged in the work of revising the standard nomenclature of diseases, and one of its members, Dr. Charles F. Folsom, secretary of the State Board of Health of Massachusetts, being then about to sail for Europe, the board availed itself of the opportunity to enable the committee, at a very trifling expense, to confer with said authorities with reference to obtaining a uniform system of nomenclature for Great Britain and her colonies and for this country. The report by Dr. Folsom of the result of his conference with the committee of the Royal College of Physicians is hereto annexed, marked Q.

MARITIME QUARANTINE.

A few weeks after the organization of the board under the constituting act of March 3, 1879, new duties were assigned to it by the quarantine act approved June 2, 1879, entitled "An act to p event the introduction of contagious and infectious diseases into the United States," and the sum of five hundred thousand dollars was appropriated to meet the expenses to be incurred in carrying out its provisions.

During the whole of the ensuing summer the efforts of the board were directed to the end of stamping out existing outLreaks of yellow fever which had already been introduced into the country; but as soon as the pressure of this exigency had ceased the board solicited an expression of the opinion of eminent legal authorities as to the measures by which it might lawfully and efficiently execute the provisions of an act which had for its main object the prevention of the introduction of contagious and infectious diseases into the United States from foreign countries and from one State to another. In conformity with the general tenor of the opinions thus gathered the board felt it to be its duty to devise some means whereby its aid could be extended to State and municipal boards of health in such a manner as would establish a reasonably satisfactory system of quarantine police for all of the ports through which infectious diseases and especially yellow fever were likely to find entrance into the United States, when the local authorities were unable without this aid to provide such sanitary safeguards for their own ports and the surrounding country.

The entire fund at its disposal would not have sufficed to establish the most moderately equipped quarantine stations at one-half of the numerous exposed ports on the South Atlantic and Gulf coasts. These ports being within the yellow-fever zone and maintaining close commercial relations with the ports of Cuba and some other tropical countries in which that fever has become permanently established, are constantly exposed to the risk of importing and then of disseminating the infection.

But even if this difficulty had not existed there was another equally embarrassing. The act of June 2, 1879, by its third section authorizes the National Board of Health to aid State and municipal boards of health "as far as it lawfully may" in the execution and enforcement of their quarantine rules and regulations. The limitation precluded the donation of the public funds to the local authorities to be used in the construction of quarantine buildings unless both the buildings and the land they occupied were made the property of the United States, in conformity with the provisions of section 355 of the Revised Statutes. When the attention of the patrons of the bill was called to this fact, and it was represented that the law would prove nugatory as to the attainment of its main object, that of preventing the importation of infectious disease from abroad, unless the funds could be applied to the construction of hospitals, lazarettos, wharves, &c., a supplementary act was introduced, and having passed both houses of Congress was approved by the President July 2, just a month after the passage of the original act. This amendment provides (sec. 6) that "the Board of Health shall have power, when they may deem it necessary, with the consent and approval of the Secretary of the Treasury, as a means of preventing the importation of contagious or infectious diseases into the United States, or into one State from another, to erect temporary quarantine buildings, and to acquire on behalf of the United States titles to real estate for that purpose, or to rent houses, if there be any suitable, at such points or places as are named in such section."

It will be observed that this provision, so far from releasing the Board from the prohibition implied by the terms of section 355 of the Revised Statutes against the application of the public money to the construction of buildings not the property of the United States, rather enforces the obligation by requiring the Board to acquire titles to real estate as a condition of the erection of temporary quarantine buildings. Relying upon this construction of the law and fortified by the concurrence of the First Comptroller of the Treasury Department it was considered expedient to establish under the auspices of the Board a few fully equipped quarantine stations so located as to avail for the protection of all the exposed ports on the South Atlantic and Gulf coasts. It was believed that this would be perfectly practicable provided the State or local authorities would require that all *infected* vessels should report to one of these national quarantine stations for inspection and treatment before attempting to enter their ports of destination. Any vessel attempting to enter any port of the United States in violation of this requirement of the State authorities would then incur all the penalties prescribed by the first section of the act approved June 2, 1879, as well as such other penalties as the local authorities may be authorized, by State or municipal legislation, to enforce.

These stations were thus proposed to be established and conducted in aid of State or municipal boards with the view of preventing the importation of infectious disease into the United States, and in every instance an earnest solicitation on the part of these authorities for the establishment of the stations in question, with a declaration of their inability without such aid to furnish adequate protection for themselves and for the country at large, preceded any action in that direction on the part of this Board. When action was taken, the Board believed that it was carrying out the wishes of the national legislature as expressed in the act of June 2, 1879, and knew that it was in complete conformity with the construction put upon that act by the highest legal authority of the government.

Inasmuch, however, as Congress failed to make the full appropriation which was estimated to be necessary for the efficient execution of the law, the Board withheld any further application of its funds to the construction of buildings, substituting therefor temporary and imperfect arrangements at the quarantine station in Sapelo Sound, off the coast of Georgia, and at Hampton Roads, in Virginia, and suspending all action in regard to proposed disbursements at

the Charleston quarantine. It was assumed in the debate in Congress on this subject that the amount of the prospective cost of these improvements, as stated in the estimates furnished by the Board, had actually been expended, and this assumption was the ground of much unfavorable criticism on the alleged extravagance of the Board. But although it was the intention of the Board to make contracts for the three stations, accidental circumstances, which have been explained in the quarterly reports, hereto appended (Appendix A), had precluded their complete consummation at the date of the act of Congress except in the single case of the Ship Island station, off the coast of Mississippi, the works at Sapelo Sound not having proceeded to the extent of the actual construction of the buildings.

In the mean time earnest applications have been addressed to this Board by the health authorities of many of the ports on the South Atlantic sea-board, from Fernandina to Norfolk, soliciting the establishment and equipment of the suspended stations, and representing their utter inability without aid from the general government to provide fully-equipped stations at their respective ports.

COST OF THE PROPOSED QUARANTINE STATIONS.

Ship Island Station.

This station, for which the contracts had been signed and the work nearly completed before the close of the last session of Congress, has been constructed at a total cost, to the 31st December, 1880, of $30,047.37, which includes the purchase of an excellent seaworthy steam-tug and other boats, the construction of wharves, warehouse, hospital, quarters for persons not sick but under observation as having been on board infected vessels, and a small building for the medical officer. These structures are temporary in the sense of being built of wood in the most economical style, but are substantial and well adapted to their uses. The cost of maintenance to December 31st was $11,455.90. It is scarcely possible to overrate the value of this station as a means of protecting the public health of the Mississippi coast and of the entire Mississippi Valley if the sanitary authorities of the State of Louisiana would co-operate with the National Board of Health in the practical measures necessary to secure the full benefits for which it may be made available.

Sapelo Sound Station.

At this station the purchase of boats and dredging of the channel as preparatory to the construction of wharves had been commenced prior to the date of the appropriation made by Congress for the fiscal year ending June 30, 1881. The total amount expended at that station during the past six months, including dredging, purchase of boats and hospital tents, and cost of maintenance, was $11,219.01. The completion of the equipment of this very important station is considered by the board to be indispensably necessary for the attainment of the ends of the law. It is respectfully submitted that this may be accomplished at an expense which is insignificant in proportion to the extent of territory which will be protected. The sanitary authorities of all the ports between Savannah and Fernandina inclusive, ports particularly exposed to the risks of infection by reason of their proximity to the West Indian foci of yellow fever, are pledged to avail themselves of the proposed quarantine.

Hampton Roads Station.

In the quarterly report for the quarter ending March 31st, extracts from which are cited in Appendix A, reference is made to the fact that operations at the proposed station in Hampton Roads were necessarily suspended by reason of the failure to obtain a title to the ground with cession of jurisdiction from the legislature of Virginia. A bill to that effect passed both houses of the legislature without opposition, but it reached the governor too late for his examination and approval before the adjournment of the legislature. This board considered that it would be hazardous to leave so important a point without any means of protection, and purchased a substantial barge, which was equipped as a floating hospital, to be moored in the Roads during the season of danger. The total cost of the barge and its equipment and maintenance of same has been $6,369.91.

It should be borne in mind that this large and commodious harbor is resorted to as a place of refuge for both domestic and foreign shipping bound to other and often distant ports, and driven in by stress of weather, or not unfrequently by the disability of the crew from some infectious disease. Numerous instances might be cited in which the latter condition was the inducing cause for which foreign vessels dangerously infected have put into the Roads for anchorage, but found no means provided for isolating and appropriately treating the sick. It is needless to say that there was more or less danger of the spreading of the disease to other shipping at anchor in the harbor.

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CONGRESSIONAL INQUIRY ON THE NECESSITY OF A NATIONAL QUARANTINE FOR THE ATLANTIC AND GULF COASTS.

In connection with the general question of the policy of establishing a limited number of quarantine stations to be conducted under the direction of the National Board of Health, it is considered pertinent and appropriate to refer to a joint resolution of Congress, approved June 6, 1872, providing "for a more effective system of quarantine on the Southern and Gulf coasts," by which the Secretary of War was directed to detail one or more medical officers of the Regular Army to visit each town and port on the coast of the Gulf of Mexico and the Atlantic coast, liable to invasion of yellow fever, and to inquire whether any system of quarantine is likely to be effective in preventing invasions of yellow fever, and, if so, what system will least interfere with the interests of commerce at said ports. Dr. Harvey E. Brown, then assistant surgeon of the United States Army, was detailed for this duty, which he discharged with signal ability, announcing his observations and conclusions in a report of great interest and value. The propositions in which he formulated the results of his exhaustive investigations, together with letters from prominent quarantine officers of southern ports, indorsing his views, are cited in Appendix R.

By the act approved June 2, 1879, "to prevent the introduction of contagious and infectious diseases into the United States," &c., Congress, in conformity with the spirit of the traditional policy of the government to concede to the individual States the right to frame their own health laws and to execute them within their respective territorial limits, authorized the National Board of Health to co-operate with and, as far as it lawfully may, to aid the State boards in the execution and enforcement of their rules and regulations to prevent the introduction of contagious and infectious diseases into the United States from foreign countries and from one State into another, thus indicating the views of the legislative department of the government as to the relations which should subsist between State and local quarantines on the one hand and a national system of quarantine on the other, with the reserve of power on the part of the general government to intervene by means of the measures specified in section 3 of the act in question for the efficient protection of the public health when the local authorities refuse or fail to make adequate provision for preventing the introduction of infection from abroad. This system, which substitutes a plan of co-operation with State and municipal boards of health under direction of the National Board in lieu of giving to the latter exclusive jurisdiction over maritime and inter-State quarantine, has been in very successful operation in most of the southern ports during the past year, and has enabled the National Board to regulate its disbursements with reference to quarantine in proportion to the special exigencies of the public health at different ports, without making distinctions which would be in contravention of the principle of the uniformity of the regulations of commerce for all the ports.

It is greatly to be regretted that the State board of health of Louisiana has hitherto rejected the offer of this board to provide a safe and convenient refuge at the Ship Island quarantine for infected vessels bound to New Orleans, although it was distinctly explained that no other than *infected* vessels need to be diverted from their usual course, and that as the number of such vessels was small the annual revenues of the Mississippi station would not be materially diminished, while much would be accomplished toward the protection of the country from the introduction of yellow fever. It is to be hoped that the views recently expressed by leading representatives of the commercial interests of New Orleans and by the public press as an exponent of the prevailing sentiment of the community, will induce the State board of health of Louisiana to reconsider its action, and to co-operate with the National Board in the measures by which it is believed that the quarantine for the protection of the Mississippi Valley may be rendered efficient as a means of sanitation with a minimum interference with trade and travel. For further details relating to the operations of the Board at and in the vicinity of New Orleans reference is respectfully made to Appendix S, containing extracts from the report of Dr. S. M. Bemiss, a member of this Board, who had charge of its interests on the Gulf coast.

INTER-STATE QUARANTINE.

Referring to the first annual report of this board, dated January 1, 1880, for a statement of the considerations which determined the board to establish inter-State quarantine for the benefit of the Mississippi Valley States, at their request, by organizing a system of sanitary inspections of steamboats and other river craft, to be conducted at various points on the Mississippi River, namely, at New Orleans, at Bayou Sara, and in the vicinity of Vicksburg, Memphis, and Cairo, the board confidently affirms that the advantages which have been realized by this instrumentality in preventing the spread of disease, in restoring confidence all along the river, and in thus preventing the imposition by State and local authorities of needless and burdensome restrictions on commerce, have been so vast as to warrant the assertion that they would have been cheaply purchased at the cost of all the money placed at the control of the board, though nothing else had been gained. This position is held to be

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ANNUAL REPORT OF THE NATIONAL BOARD OF HEALTH FOR 1880.

NATIONAL BOARD OF HEALTH,
WASHINGTON, D. C., *January* 1, 1881.

The National Board of Health, in making its second annual report, feels that it has a right to congratulate the country upon the general results of its labors since it went into operation in April, 1879. These results, as will be more particularly shown in the sequel, have reference either to the investigation of the causes of disease by means of scientific experiments and by sanitary surveys of places more than usually unhealthy, or likely to become so, or to measures which have for their end the prevention of the introduction of contagious and infectious diseases into the United States from foreign countries, or from one State into another.

It is hoped that before many years have passed the people will have become so educated to the idea of public sanitation that not only every State and Territory, but every township, will have its own board of health, in the assured conviction that it is far better to provide for the prevention than for the cure of disease, especially for those pestilential diseases of indigenous and local origin, for which, in all probability, a preventive remedy may be found in careful and habitual attention to local sanitation, while other machinery must be invoked to deal with those more pervasive pestilences which, introduced from abroad as an incident of commerce, may overrun and devastate vast territories, and which, in order to be checked, require the intervention of the strong arm of the general government in the exercise of its powers to regulate commerce with foreign countries and between the several States. Of these two functions of the National Board of Health, as determined respectively by the constituting act, approved March 3, 1879, and by the act to "prevent the introduction of contagious and infectious diseases into the United States," approved June 2, 1879, the former is recommended to the support of the national legislature for the two-fold reason that the resulting benefits will not be the exclusive possession of any one section of the country, but will apply equally to all, and that the cost of conducting such investigations is beyond the means of private individuals or of the separate States.

In this connection it is pertinent to allude to the great impulse given to the progress of preventive medicine by the special scientific investigations conducted by experts appointed for the purpose by the Local Government Board of England, and published in connection with the reports of the medical officer of the Privy Council. In regard to the value of these scientific investigations in their relation to the increase of our resources for the prevention and cure of disease, there can be but one opinion among those who are competent to judge. One of the most notable and beneficent improvements in modern surgery, the practice of the antiseptic treatment of wounds, is believed to have reduced the mortality of many of the graver surgical operations by at least fifty per cent.; and this remarkable result, which, with equal truth, may be affirmed with respect to the death-rate of accidental wounds, is justly accredited to the investigations of a few zealous votaries of science on the life-history of certain microscopic organisms, investigations which, when first undertaken, were seemingly remote from any probability of being immediately applicable to purposes of practical utility. Many others, of equal significance, might readily be cited to illustrate the bearing of scientific researches on the enlargement of our means of preventing and of curing disease. In an earnest appeal to the Privy Council to continue these investigations it was urged by their distinguished medical officer that where research, if it is to succeed, requires systematic and continuous labor extending over long periods of time—labor not only inconducive to immediate pecuniary profits, but, perhaps, involving much cost—it can hardly be expected that the study, however great its eventual importance, will be adequately cultivated by private investigators.

To set on foot and direct such investigations by means of competent experts appointed and paid by the National Board of Health, to obtain information upon all matters affecting the public health, to advise the several departments of the government, the executives of the several States, and the Commissioners of the District of Columbia, on all questions submitted by them, or whenever in the opinion of the board such advice may tend to the preservation and improvement of the public health, were the obligations imposed on this board by the act of March 3, 1879.

In the discharge of these duties the board has since the date of its organization set on foot the following investigations and inquiries, a few of which are still in progress, the others having been finally completed. Most of them have been noticed in former reports with appropriate explanations as to their end and methods, which it would be unnecessary to repeat at this time.

I. The collection of information and advice from the principal sanitary organizations and sanitarians of the United States as to the best plan for a national public health organization, including the subject of quarantine, both maritime and inland, and the relations which should exist between State and local systems of quarantine, and a national quarantine system. The information thus collected and the report of the National Academy of Sciences, which had been required to co-operate with the board in deducing conclusions from such information, were embodied in the first annual report of this board.

II. The investigation of yellow fever in the Island of Cuba by a commission of experts consisting of Dr. S. E. Chaillé and Col. T. S. Hardie, C. E., of New Orleans, Dr. G. M. Sternberg, U. S. A., and Dr. John Guitéras, of Philadelphia. The final report of this commission has been received and is appended hereto. See Appendix B.

III. The collection of the sanitary laws of the United States and of the several States, including both the statutes and the decisions of the several courts on all questions involving the public health. A large part of this work, that, namely, relating to judicial decisions by R. C. Lincoln, esq., of Boston, has been completed, the remaining part being in progress under the direction of E. B. Smith, esq., of the law department of the United States Government.

IV. An investigation as to the best method of determining the amount and character of organic matter in the air has been completed by Prof. Ira Remsen, of the Johns Hopkins University, of Baltimore, whose preliminary report on the same subject has heretofore been transmitted to Congress in connection with the first annual report of this Board. The final report is hereto appended, marked C.

V. An investigation as to the effects of disinfecting agents upon the causes of the infectious diseases was assigned, under the general direction of Dr. C. F. Folsom, to Dr. W. S. Bigelow, of Boston, who would be assisted by Dr. H. P. Bowditch, professor of physiology, and Dr. Wood, professor of chemistry, in Harvard University. No report has yet been received from these gentlemen; but it is understood that this very important investigation has been commenced and is now in progress. During the past year a series of experiments designed to test the value of certain gaseous and volatile disinfectants was made by Dr. George M. Sternberg, U. S. A.

VI. An investigation as to the composition and merits of the various patent disinfectants, by Prof. C. F. Chandler, of Columbia College, New York, president of the Board of Health of the City of New York, assisted by Elwyn Waller, Ph. D.

VII. An investigation into the adulterations of food in the United States, by Prof. R. M. Kedzie, M. D., president of the State Board of Health of Michigan, and by Prof. Lewis Diehl, of Louisville, Ky., as to the adulterations of drugs, both of whose reports together with a later and more detailed report, by Dr. Charles Smart, on adulterations of food recently completed are appended hereto marked Appendix E.

VIII. A preliminary inquiry as to the communicable diseases of animals, by Prof. James Law, of Cornell University, Ithaca, N. Y., which will be found in Appendix F. A report on the same subject, by Dr. T. S. Verdi, a member of this Board, has been heretofore transmitted to Congress as an appendix to the first annual report of the Board.

IX. An investigation of the flow of sewers in relation to their sizes and gradients, by Col. George E. Waring, jr., of Newport, R. I., whose final report is hereto appended marked G, a preliminary report having been heretofore transmitted to Congress.

X. A report by Dr. Elisha Harris, of New York, upon diphtheria, as it occurred in Northern Vermont.

XI. An investigation by Prof. Raphael Pumpelly, of the United States Geological Survey, aided by Prof. George A. Smyth, upon the influence of various soils upon sanitation, which is still in progress, and promises to yield results of great scientific interest and practical sanitary value. Very recently the Board has authorized Dr. George M. Sternberg, U. S. A., to assist in this investigation with reference to its biological relations.

XII. An investigation by Drs. H. C. Wood and H. F. Formad, of Philadelphia, as to the effects of inoculating lower animals with diphtheritic exudation. (See Appendix H.) Within the past few weeks Dr. Wood has been authorized to continue his researches on this most important subject.

XIII. Researches by Dr. G. M. Sternberg, U. S. A., upon suspended particles in the air of places liable to infection, which were com-

menced in Havana and have been renewed in New Orleans. These researches include an investigation upon organized particles from swamps and other malarious localities, with the view of testing the accuracy of the observations of Klebs and Tomassi-Crudeli, and others, on the existence of spores alleged to be the producing cause of malarial fevers. (Appendix I.)

XIV. A report by Dr. J. J. Woodward, U. S. A., on the Pathological Histology of Yellow Fever, is hereto annexed, marked K.

XV. A report by Professor Abbe, of the Signal Service Bureau, on the possible relations between meteorological phenomena and vital statistics, and especially on the graphical methods of representing such data, which report, with the accompanying illustrative diagrams and charts, will be found in Appendix L.

XVI. An investigation by Col. G. E. Waring, jr., of Newport, R. I., on the influence of the water-seal of traps of different kinds of currents of water passing through them or through the pipes into which they deliver, under a variety of conditions, covering ventilation, copious or partial, and induced currents arising from the passage of water over the branches of different form and arrangement, including experiments with regard to siphoning and the best manner to secure an adequate flush for water-closets, drains, &c.

XVII. An investigation by Prof. Ira Remsen, of the Johns Hopkins University, Baltimore, as to the amount of carbonic oxide in furnace-heated rooms.

XVIII. An investigation under the direction and supervision of Prof. J. W. Mallet, of the University of Virginia, on the best method of determining the amount of organic matter in potable water, and its effect on the health of persons who drink such water. This work will involve the co-operation of three distinct analysts, each employing a different method from the rest.

XIX. The history of quarantine in the United States, exhibiting the occasions which give rise to quarantine legislation, or attempts at such legislation by States or by the general government, prepared by Dr. Stephen Smith, a member of the Board.

SANITARY SURVEYS.

The following sanitary surveys have been conducted under the auspices of the board:

I. A sanitary survey of the eastern coast of New Jersey bordering on New York Harbor, carried on with the aid of this board, under the direction of the State Board of Health of New Jersey.

II. A sanitary survey of the City of Memphis, Tennessee, under the direction of a special committee of this board, of which Dr. J. S. Billings was the chairman. The final report of this committee, marked M, is hereto appended. In connection with this survey Dr. Charles Smart, U. S. A., has furnished a full report on the condition of the water supply of Memphis, and also of certain smaller towns in Mississippi, which is appended to the report on the sanitary survey.

III. A report by Dr. Charles Smart on the water supply of Mobile and New Orleans. (See Appendix N.)

IV. A sanitary survey of selected portions of Baltimore City was undertaken by this board, in compliance with the request of the city council, and Dr. C. W. Chancellor, secretary of the State Board of Health, was appointed a special sanitary inspector to conduct the work. His report and the correspondence which preceded and followed the work are appended hereto, marked O.

VITAL STATISTICS AND NOMENCLATURE OF DISEASES.

In the quarterly report of this board for the quarter ending June 30, 1880, reference was made to a conference held in Washington on the 6th and 7th of May, to which the registrars of vital statistics of the different States and municipalities, and all persons interested in the subject, had been invited The report of the proceedings of the conference, as published in Supplement No. 5 to the BULLETIN, was appended to the said quarterly report. At a subsequent date the committee appointed by the conference to consider the best method of tabulating mortality statistics made a report on that subject, a copy of which is hereto annexed, marked P.

The same committee having been charged with the duty of conferring with the committee of the Royal College of Physicians in London, engaged in the work of revising the standard nomenclature of diseases, and one of its members, Dr. Charles F. Folsom, secretary of the State Board of Health of Massachusetts, being then about to sail for Europe, the board availed itself of the opportunity to enable the committee, at a very trifling expense, to confer with said authorities with reference to obtaining a uniform system of nomenclature for Great Britain and her colonies and for this country. The report by Dr. Folsom of the result of his conference with the committee of the Royal College of Physicians is hereto annexed, marked Q.

MARITIME QUARANTINE.

A few weeks after the organization of the board under the constituting act of March 3, 1879, new duties were assigned to it by the quarantine act approved June 2, 1879, entitled "An act to p event the introduction of contagious and infectious diseases into the United States," and the sum of five hundred thousand dollars was appropriated to meet the expenses to be incurred in carrying out its provisions.

During the whole of the ensuing summer the efforts of the board were directed to the end of stamping out existing outbreaks of yellow fever which had already been introduced into the country; but as soon as the pressure of this exigency had ceased the board solicited an expression of the opinion of eminent legal authorities as to the measures by which it might lawfully and efficiently execute the provisions of an act which had for its main object the prevention of the introduction of contagious and infectious diseases into the United States from foreign countries and from one State to another. In conformity with the general tenor of the opinions thus gathered the board felt it to be its duty to devise some means whereby its aid could be extended to State and municipal boards of health in such a manner as would establish a reasonably satisfactory system of quarantine police for all of the ports through which infectious diseases and especially yellow fever were likely to find entrance into the United States, when the local authorities were unable without this aid to provide such sanitary safeguards for their own ports and the surrounding country.

The entire fund at its disposal would not have sufficed to establish the most moderately equipped quarantine stations at one-half of the numerous exposed ports on the South Atlantic and Gulf coasts. These ports being within the yellow-fever zone and maintaining close commercial relations with the ports of Cuba and some other tropical countries in which that fever has become permanently established, are constantly exposed to the risk of importing and then of disseminating the infection.

But even if this difficulty had not existed there was another equally embarrassing. The act of June 2, 1879, by its third section authorizes the National Board of Health to aid State and municipal boards of health "as far as it lawfully may" in the execution and enforcement of their quarantine rules and regulations. The limitation precluded the donation of the public funds to the local authorities to be used in the construction of quarantine buildings unless both the buildings and the land they occupied were made the property of the United States, in conformity with the provisions of section 355 of the Revised Statutes. When the attention of the patrons of the bill was called to this fact, and it was represented that the law would prove nugatory as to the attainment of its main object, that of preventing the importation of infectious disease from abroad, unless the funds could be applied to the construction of hospitals, lazarettos, wharves, &c., a supplementary act was introduced, and having passed both houses of Congress was approved by the President July 2, just a month after the passage of the original act. This amendment provides (Sec. 6) that "the Board of Health shall have power, when they may deem it necessary, with the consent and approval of the Secretary of the Treasury, as a means of preventing the importation of contagious or infectious diseases into the United States, or into one State from another, to erect temporary quarantine buildings, and to acquire on behalf of the United States titles to real estate for that purpose, or to rent houses, if there be any suitable, at such points or places as are named in such section."

It will be observed that this provision, so far from releasing the Board from the prohibition implied by the terms of section 355 of the Revised Statutes against the application of the public money to the construction of buildings not the property of the United States, rather enforces the obligation by requiring the Board to acquire titles to real estate as a condition of the erection of temporary quarantine buildings. Relying upon this construction of the law and fortified by the concurrence of the First Comptroller of the Treasury Department it was considered expedient to establish under the auspices of the Board a few fully equipped quarantine stations so located as to avail for the protection of all the exposed ports on the South Atlantic and Gulf coasts. It was believed that this would be perfectly practicable provided the State or local authorities would require that all *infected* vessels should report to one of these national quarantine stations for inspection and treatment before attempting to enter their ports of destination. Any vessel attempting to enter any port of the United States in violation of this requirement of the State authorities would then incur all the penalties prescribed by the first section of the act approved June 2, 1879, as well as such other penalties as the local authorities may be authorized, by State or municipal legislation, to enforce.

These stations were thus proposed to be established and conducted in aid of State or municipal boards with the view of preventing the importation of infectious disease into the United States, and in every instance an earnest solicitation on the part of these authorities for the establishment of the stations in question, with a declaration of their inability without such aid to furnish adequate protection for themselves and for the country at large, preceded any action in that direction on the part of this Board. When action was taken, the Board believed that it was carrying out the wishes of the national legislature as expressed in the act of June 2, 1879, and knew that it was in complete conformity with the construction put upon that act by the highest legal authority of the government.

Inasmuch, however, as Congress failed to make the full appropriation which was estimated to be necessary for the efficient execution of the law, the Board withheld any further application of its funds to the construction of buildings, substituting therefor temporary and imperfect arrangements at the quarantine station in Sapelo Sound, off the coast of Georgia, and at Hampton Roads, in Virginia, and suspending all action in regard to proposed disbursements at

the Charleston quarantine. It was assumed in the debate in Congress on this subject that the amount of the prospective cost of these improvements, as stated in the estimates furnished by the Board, had actually been expended, and this assumption was the ground of much unfavorable criticism on the alleged extravagance of the Board. But although it was the intention of the Board to make contracts for the three stations, accidental circumstances, which have been explained in the quarterly reports, hereto appended (Appendix A), had precluded their complete consummation at the date of the act of Congress except in the single case of the Ship Island station, off the coast of Mississippi, the works at Sapelo Sound not having proceeded to the extent of the actual construction of the buildings.

In the mean time earnest applications have been addressed to this Board by the health authorities of many of the ports on the South Atlantic sea-board, from Fernandina to Norfolk, soliciting the establishment and equipment of the suspended stations, and representing their utter inability without aid from the general government to provide fully-equipped stations at their respective ports.

COST OF THE PROPOSED QUARANTINE STATIONS.

Ship Island Station.

This station, for which the contracts had been signed and the work nearly completed before the close of the last session of Congress, has been constructed at a total cost, to the 31st December, 1880, of $30,047.37, which includes the purchase of an excellent seaworthy steam-tug and other boats, the construction of wharves, warehouse, hospital, quarters for persons not sick but under observation as having been on board infected vessels, and a small building for the medical officer. These structures are temporary in the sense of being built of wood in the most economical style, but are substantial and well adapted to their uses. The cost of maintenance to December 31st was $11,455.90. It is scarcely possible to overrate the value of this station as a means of protecting the public health of the Mississippi coast and of the entire Mississippi Valley if the sanitary authorities of the State of Louisiana would co-operate with the National Board of Health in the practical measures necessary to secure the full benefits for which it may be made available.

Sapelo Sound Station.

At this station the purchase of boats and dredging of the channel as preparatory to the construction of wharves had been commenced prior to the date of the appropriation made by Congress for the fiscal year ending June 30, 1881. The total amount expended at that station during the past six months, including dredging, purchase of boats and hospital tents, and cost of maintenance, was $11,219.01. The completion of the equipment of this very important station is considered by the board to be indispensably necessary for the attainment of the ends of the law. It is respectfully submitted that this may be accomplished at an expense which is insignificant in proportion to the extent of territory which will be protected. The sanitary authorities of all the ports between Savannah and Fernandina inclusive, ports particularly exposed to the risks of infection by reason of their proximity to the West Indian foci of yellow fever, are pledged to avail themselves of the proposed quarantine.

Hampton Roads Station.

In the quarterly report for the quarter ending March 31st, extracts from which are cited in Appendix A, reference is made to the fact that operations at the proposed station in Hampton Roads were necessarily suspended by reason of the failure to obtain a title to the ground with cession of jurisdiction from the legislature of Virginia. A bill to that effect passed both houses of the legislature without opposition, but it reached the governor too late for his examination and approval before the adjournment of the legislature. This board considered that it would be hazardous to leave so important a point without any means of protection, and purchased a substantial barge, which was equipped as a floating hospital, to be moored in the Roads during the season of danger. The total cost of the barge and its equipment and maintenance of same has been $6,369.91.

It should be borne in mind that this large and commodious harbor is resorted to as a place of refuge for both domestic and foreign shipping bound to other and often distant ports, and driven in by stress of weather, or not unfrequently by the disability of the crew from some infectious disease. Numerous instances might be cited in which the latter condition was the inducing cause for which foreign vessels dangerously infected have put into the Roads for anchorage, but found no means provided for isolating and appropriately treating the sick. It is needless to say that there was more or less danger of the spreading of the disease to other shipping at anchor in the harbor.

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It is greatly to be regretted that the State board of health of Louisiana has hitherto rejected the offer of this board to provide a safe and convenient refuge at the Ship Island quarantine for infected vessels bound to New Orleans, although it was distinctly explained that no other than *infected* vessels need to be diverted from their usual course, and that as the number of such vessels was small the annual revenues of the Mississippi station would not be materially diminished, while much would be accomplished toward the protection of the country from the introduction of yellow fever. It is to be hoped that the views recently expressed by leading representatives of the commercial interests of New Orleans and by the public press as an exponent of the prevailing sentiment of the community, will induce the State board of health of Louisiana to reconsider its action, and to co-operate with the National Board in the measures by which it is believed that the quarantine for the protection of the Mississippi Valley may be rendered efficient as a means of sanitation with a minimum interference with trade and travel. For further details relating to the operations of the Board at and in the vicinity of New Orleans reference is respectfully made to Appendix S, containing extracts from the report of Dr. S. M. Bemiss, a member of this Board, who had charge of its interests on the Gulf coast.

INTER-STATE QUARANTINE.

Referring to the first annual report of this board, dated January 1, 1880, for a statement of the considerations which determined the board to establish inter-State quarantine for the benefit of the Mississippi Valley States, at their request, by organizing a system of sanitary inspections of steamboats and other river craft, to be conducted at various points on the Mississippi River, namely, at New Orleans, at Bayou Sara, and in the vicinity of Vicksburg, Memphis, and Cairo, the board confidently affirms that the advantages which have been realized by this instrumentality in preventing the spread of disease, in restoring confidence all along the river, and in thus preventing the imposition by State and local authorities of needless and burdensome restrictions on commerce, have been so vast as to warrant the assertion that they would have been cheaply purchased at the cost of all the money placed at the control of the board, though nothing else had been gained. This position is held to be

fully justified by the facts and testimony cited in the report of Dr. R. W. Mitchell, a member of this board assigned to special duty as director of the service, under whose judicious and energetic administration such favorable results were realized. Attention is specially invited to the testimony of the Memphis Cotton Exchange and kindred bodies in Little Rock, Ark., Shreveport, La., Vicksburg, Miss., and elsewhere; by the general superintendent of the Mississippi and Tennessee Railroad, and the officers of other leading railroad lines; by the superintendent of the Saint Louis and Vicksburg Anchor Line of Packets, and the representatives of various other similar lines of railroad and packet companies, as cited in Dr. Michell's report, a copy of which, marked T, is appended hereto. The largest item of expense incurred in connection with this service was the cost of the sanitary patrol boat, the H. H. Benner, used to enable the director of the service to visit inspecting stations, to board steamers in transit, and in case of epidemics to convey assistance to isolated communities. Had the board possessed such a patrol boat in the summer of 1879, there can scarcely be a doubt but that it would have been possible to stamp out the disease in several places before it had caused a tithe of the mortality and interruption to business which ensued in those localities.

In this connection it is pertinent to refer to the significant testimony of Dr. J. H. Rauch, secretary of the State Board of Health of Illinois, which, having been addressed directly to this office, was not cited in Dr. Mitchell's report.

EFFECTS OF QUARANTINE ON INTER-STATE TRAFFIC.

Inclosed herewith please find an official report of the tonnage of the Illinois Central Railroad at Cairo for the last six months of the years 1878 and 1879.

Tonnage forwarded from and received at Cairo.

Months.	Forwarded.	Forwarded.	Received.	Received.
	1878.	1879.	1878.	1879.
July	10,071,800	20,914,900	28,550,200	48,574,600
August	10,510,400	19,050,200	31,124,000	52,575,200
September	10,282,200	17,218,200	23,864,100	60,671,600
October	10,491,600	22,523,600	48,459,500	71,044,000
November	10,004,500	27,050,100	61,854,600	60,066,700
December	26,940,100	23,076,800	70,558,800	74,137,700
Total	87,300,600	129,833,800	267,411,200	367,069,800

In this statement will be found an illustration of the effect upon commerce by the different systems in vogue in the management of yellow fever in the respective years. While it is true that the general increase of trade had its influence, it is fair to assume that this is not sufficient to account for the difference that obtains in the statement. In 1878, there was practically a quarantine excluding everything that came from the South, while in 1879 it was one of inspection, excluding only dangerous articles. This result could not have been brought about without the co-operation of the National Board of Health, as our board without this co-operation could not have permitted the immense amount of material to be brought into the State from the South during the months of July, August, September, and October. It required my constant presence at Cairo (especially in July) and my repeated assurances to the local authorities that every precaution was being exercised at New Orleans and along the entire route to prevent the introduction and spread of the fever northward to allay their fears, as this year a large number of the citizens of Cairo were favorable to a quarantine of exclusion Such was the feeling of apprehension that fully one-third of the population of Cairo, from July 15 to September 1, were ready to leave the moment the first case appeared, no matter whether it was of foreign or local origin.

The Illinois Central Railroad pays to the State of Illinois 7 per cent. of its net earnings, and it is not presumption to say that the increase of revenue, as the result of the course pursued during the months of July, August, September, and October, 1879, amounted to more than three times the amount appropriated by the State for sanitary purposes. It must also be borne in mind that this does not include a statement of the difference in the receipts from passengers, or the trade of the Cairo and Vincennes and Cairo and Saint Louis railroads, and of the river traffic.

To the same cause can be attributed the fact that we did not have a single case of yellow fever in our State in 1879."

In view of such beneficent results in the protection of the public health and the removal of disastrous obstructions to inter-State commerce, the board is strongly impressed with the force of the considerations presented by Dr. Mitchell in favor of the policy of extending the service in question so as to include that portion of the Mississippi which is between its mouth and the city of New Orleans. If their expectations with regard to the probable prospective co-operation of the State Board of Health of Louisiana in connection with this service should be fully realized, the estimated cost of the additional equipments for the service will be insignificant in comparison with the positive and material benefits to be gained.

FINANCES OF THE BOARD.

In deference to the will of Congress, as indicated in the debate on the sundry civil appropriations in the last days of the last session, the Board suspended its proposed operations on Blackbeard Island, in Sapelo Sound, and at Hampton Roads, and in consequence thereof the disbursements for the last six months have been short of the estimates submitted to Congress last year. But it is respectfully submitted that there is a very urgent need of substituting for the imperfect quarantine arrangements at Norfolk and on the Georgia coast a more effective instrumentality for preventing the introduction of infectious diseases from foreign countries, and an equally urgent necessity for establishing a similar quarantine station on the coast of Texas. Moreover, the Mississippi River inspection service will be greatly improved at a small additional annual cost by the adoption of the measures recommended by Dr. Mitchell in his report.

To meet these and other desirable ends, the Board submits its estimates for the fiscal year ending June 30, 1882, and earnestly solicits the approval by Congress of a policy which, according to the testimony of boards of trade and chambers of commerce, and other parties interested in inter-State commerce, has promoted that commerce in so considerable a degree, while at the same time giving more or less effective protection to the public health, so far as the same may be endangered by the transit of infected persons or things on the public highways, and their introduction into places previously exempt from infectious diseases.

In this connection the Board takes occasion to say that although by the concurrent opinion of the most eminent yellow-fever experts there were several cases of that disease in the vicinity of New Orleans, and although a number of undoubted cases have recently occurred at Key West, the Board did not deem it expedient to use any part of the contingent appropriation of $100,000 provided for such cases. This decision seemed to be justified by the fact that in neither case was there manifested any disposition to the spreading of the disease beyond the localities in which it first appeared.

The case of Key West is a peculiar and exceptional one, and for reasons set forth in the report of Dr. Cochran, a sanitary inspector of this Board, a copy of which will be found in the appendix of the last annual report, the Board did not consider it necessary or expedient to report the facts to the President of the United States with a view to the establishment of a compulsory quarantine in conformity with the provisions of section 3, act approved June 2, 1879, to prevent the introduction of contagious and infectious diseases into the United States. The cost of such an establishment would probably be disproportionate to the resulting benefits in view of the comparatively slight danger of the transmission of the infection from that city, except by sea-going vessels which, if bound to other United States ports, can be quarantined at the ports of final destination. In view, however, of the frequently recurring introduction of yellow fever into Key West and the refusal of its authorities to apply measures of quarantine, this Board has considered it to be its duty to advise the health authorities of all ports having communication with Key West during warm weather to take special precautions in dealing with vessels from that port.

In accordance with the views hereinbefore stated the following estimates of expenditures for the fiscal year ending June 30, 1882, are respectfully submitted, along with a statement of expenditures from the organization of the Board to December 31, 1880, with a statement in detail of the expenditures for the last two quarters.

It is also requested that the contingent appropriation of $100,000, which was to be available in the event of an outbreak of epidemic disease, be renewed under the same conditions for the next fiscal year.

Statement of the expenditures of the National Board of Health for the six months ending December 31, 1880.

On what account.	Total for quarter ending September 30, 1880.	Total for quarter ending December 31, 1880.	Total for the 6 months ending December 31, 1880.
Floating quarantine on Mississippi river	$9,988 39	$8,339 21	$18,327 60
Ship Island quarantine	11,737 28	10,777 10	22,514 38
Blackbeard Island quarantine	2,767 42	1,782 11	4,549 53
Elizabeth River quarantine	2,317 75	240 00	2,557 75
Aid to Pensacola, Fla	3,195 63	1,066 59	4,262 22
Aid to Pascagoula, Miss	97 58	71 70	169 28
Aid to Hancock County, Mississippi	319 35	300 00	619 35
Aid to Harrison County, Mississippi	353 70	413 20	766 90
Aid to State board of health, Louisiana	1,490 00	411 90	1,901 90
Aid to State board of health, Texas	125 00	150 00	275 00
Aid to Charleston, S. C	40 20	1,114 25	1,154 45
Havana Commission	662 30	....	662 30
Pay and expenses inspectors at Havana, Memphis, &c	5,069 15	2,051 00	7,120 15
Special scientific investigations	849 73	1,900 33	2,750 06
Pay and expenses members of the Board	2,559 20	1,938 08	4,497 28
Storage of tents, &c	260 75	....	260 75
Printing of the Bulletin of National Board of Health	2,147 89	2,131 05	4,278 94
Printing of blanks, &c	172 65	58 07	230 72
Pay of clerks, messengers, &c	4,450 39	4,488 99	8,939 38
Rent, light, and fuel	212 40	330 80	543 20

feet square, respectively. The one used as quarters for the boatmen belonging to the station is set on posts about ten or twelve feet above ground, and is in a dilapidated condition. The other, used by the quarantine officer as a residence, has two rooms and a kitchen, and is raised about 12 feet above ground, on piling driven 8 feet into the sand. There is a wharf 160 feet long to the landing for the quarantine officer's yawl. Two yawls, 18 feet long, 8 inches draught, and one skiff, belong to the station. There is also one wall-tent. There is no furniture at the station except one table and two or three chairs, one signal light, and "several lights and lanterns used about the houses." This information I obtained from Dr. M. R. Brown, quarantine officer in charge during 1879.

The regular session of the sixteenth legislature, 1879, appropriated for quarantine purposes as follows: "For pay of State health officer, and for expenses incurred under quarantine laws in the State, $20,000 a year for two years.

"For building quarantine station houses at such points as the health officer may deem advisable, $5,000." (*Vide* ch. 148, p. 157, General Laws of Texas, 1879, reg. sess.)

At the special session, sixteenth legislature, 1879, $7,000 additional was appropriated "for quarantine buildings, wharves, &c., for quarantine purposes, provided it be used at the following points and places: Brazos de Santiago, Corpus Christi, Indianola, Galveston, Sabine Pass, Orange, Denison, Texarkana, and Marshall." (*Vide* General Laws, ch. 37, p. 34, special session 16th leg., 1879.)

It will thus be seen that $12,000 was the total appropriated for buildings, wharves, &c., for all the stations (nine in number) on the Gulf coast and inland border.

Out of this appropriation the State health officer has had erected, on Pelican Island, two buildings, the plan of which I send you. One of these buildings is a hospital, the other for quarantine officer and assistants. They are located about the tripod marked in red ink on Pelican Island (see tracing).

There are no warehouse facilities, no barges or lighters for transferring cargo.

I think one complete quarantine station on the Texas coast would, for the present, relieve the commerce of Texas from the embargo placed on it by non-intercourse quarantine. In consultation with the health authorities here, they express themselves in favor of allowing commerce to go on, if the vessels, cargo, crew, and passengers can be subjected to proper treatment at a complete quarantine establishment. From my experience at the ports west of this during the last summer, I am of the opinion that the principal thing in the way of a national quarantine on this coast is want of facilities for handling cargoes, &c., that may be from infected ports. You ask whether such station "should be established at Galveston or farther west on the coast." I think some point near the entrance to Galveston Bay would be most suitable, and for the following reasons: 1. It is most convenient for the commerce of Texas. The commerce of Sabine Pass is principally a coasting lumber trade with ports west of it. The entrance to the ship channel leading to Clinton and thence by rail to Houston is through Galveston Bay. The geographical position of Galveston makes it more nearly on the route of vessels plying between Indianola, or Corpus Christi, or Brazos de Santiago, and ports most liable to become infected with yellow fever, except the trade between Mexican ports and Texas ports west of Galveston. But this Mexican trade with ports west of Galveston is very light; nearly all the commerce between Mexican and Texas ports enters at Galveston.

There is a line of English steamships that ply between Liverpool, Hamburg, and Bordeaux, and Brazos de Santiago via Vera Cruz and other Mexican ports. Their principal cargo is bonded goods for Matamoros and interior of Mexico. They do not bring much from Mexican ports for Brazos de Santiago—occasionally some passengers. The chief source of danger is from taking on goods for Europe at infected Mexican ports, and mixing with cargo destined for Brazos de Santiago—thus infecting the whole cargo. It occurs to me that the simplest remedy for this would be for these ships to come first to Brazos de Santiago and go thence to the Mexican ports. In my inquiries last summer, I could ascertain no reason why this could not be done, except that by the route the vessels take now they obtain some advantage of winds and currents.

The Indianola cattle trade with Havana is a very important one, but Galveston does not lie far out of the route taken by the ships. A large majority of the vessels enter at Galveston that come to Texas from ports most liable to have yellow fever, and in fact any disease for which quarantine is established. The ports I refer to are the Mexican, South American, West Indian, and South Atlantic, and Gulf ports of the United States.

So much for the commerce as it is now. If in the future the ports west of this should have their railways so extended to the interior as to largely increase their importance as ports of entry, and an additional quarantine station should be needed, the curved line of the Texas coast would seem to make it desirable to have the stations as near as possible the extremities of the arc; so that one or the other of such stations would lie near the route of vessels coming from any direction. In such event, Galveston would be a better point for the present station than a point farther west.

2. I am assured the land for site can be procured without cost in Galveston Bay. I have addressed the following communication to the mayor and council of Galveston in reference to this point:

"GALVESTON, TEX., *March* 19, 1880.

"*To the Hon. Mayor and Common Council, City of Galveston:*

"GENTLEMEN: I have the honor to request information on the following points, to be transmitted to the office of the National Board of Health, Washington: Has the city of Galveston, through its mayor and council, such jurisdiction over Pelican Island as to grant the use of said island to the National Board of Health for the purpose of erecting and maintaining a quarantine establishment for the benefit of the commerce of Galveston and other accessible ports—such a quarantine establishment, for instance, as is proposed to be erected at Ship Island? If the city has such jurisdiction, will it grant the use of said island to the National Board of Health for the purposes indicated, in consideration of the National Board of Health erecting and maintaining such quarantine establishment?

"A reply at your earliest convenience will very much oblige your obedient servant,

"JOHN H. POPE.
"*Sanitary Inspector N. B. of H.*"

The mayor assured me he would get the council together as soon as possible and act on the communication. In conversation with the mayor and two of the aldermen I was told they had no doubt the island could and would be granted as requested. The city cannot sell the island, nor can it be sold under execution or otherwise to pay any debt of the city. The meeting of the council will probably be held next Wednesday, 24th instant. I will forward the answer.

The land about entrance to Matagorda Bay is either the property of private individuals, and would have to be purchased or condemned and appraised by a commission, or it is the property of the State, and would require an act of the legislature to pass title. Besides, isolation could not be made so satisfactory on either Matagorda Peninsula or on the islands on the other side of the channel.

Pelican Island is the most suitable point in Galveston Bay for the location of a quarantine station. The only other place I thought worth considering was Bolivar Peninsula. This is leased and occupied by the government force in charge of the harbor improvements.

Pelican Island is north of Galveston about three miles, and is a little less distant from the mainland. It lies between the channel leading up to Clinton and the one leading to Galveston wharf. The island is about one and a half miles long and about three-fourths of a mile broad at its widest part. It is composed of shell and sand, and has an elevation or ridge running almost the entire length of the island near its northern shore. The top of this ridge is from three to four and a half feet above ordinary high tide. The ridge is from 100 to 200 feet wide. South of this ridge the island is low and flat—subject to overflow in high tide. In addition to the grassy vegetation growing on most of the island, the ridge is covered with a chaparral or thicket of scrubby growth, some of which is mesquite.

It is said the island was submerged during the cyclone of 1875 only to the depth of ten inches. Vessels drawing only ten inches went aground on this island during the severest part of that storm.

The buildings of the proposed quarantine station should be located along the ridge. The warehouse and wharf would be somewhere near the tripod (marked in red ink on the tracing). If possible, it should be farther east, but this will have to depend on the narrowness of the channel. The wharf should be extended out to 10 feet water.

The quarters for passengers not sick should be toward the west end of the island, where they could be isolated and have that portion of the island for outdoor exercise and recreation. The hospitals for sick with other than infectious diseases should be next in order as we go from west to east; then quarters for officers and men in charge of station; then warehouse and wharf, and finally hospitals for infectious diseases, except small-pox, for which a hospital could be located on the south side of the island, where the fisherman's hut is.

It will require a wharf about 1,900 feet long, according to latest charts, to reach a channel of water 10 feet deep. I would advise that soundings be made before the exact location is determined on.

All the buildings should be on piling extending about 8 feet into the ground and 4 or 5 feet above ground. This opinion is founded on the judgment of those better acquainted than I am with the effects of the gales and cyclones on this coast. There should at least be a sufficient number of the houses raised thus on stout piles to insure refuge in the event of a storm.

As to the capacity of the warehouse, it should be large enough to accommodate the cargo of a 2,500-ton vessel. There is only one vessel entering here larger than this, to wit, the *Colorado*, 2,750 tons. The heaviest draught vessels are those running between this and New York City. The average tonnage of the steamships entering here is about 1,200 or 1,300 tons. Vessels engaged in the South American and Mexican trade are smaller. If success follows the efforts to deepen the bar larger vessels will doubtless come to this port. But this will at least be several years.

The buildings erected by the State, I have no doubt, would be allowed to the National Board of Health for their use in the event the proposed station were established here. These could be utilized as quarters for officers and men, or some other purpose. These buildings require some repairs on account of the mischief inflicted by picnic or fishing parties. They also require some additional work to make them ready for use. Some of the walls are badly warped on

I certify that the foregoing is a correct copy from proceedings Galveston board of health, March 20, 1880.

[SEAL.] CLARK CAMPBELL, M. D.,
Secretary Board of Health.

Attest.

P. S. WREN, *City Clerk.*

Extract from report for quarter ending June 30, 1880.

Referring to the quarterly report for the quarter ending June 30, 1880, for an exposition of the views and purposes then entertained by this Board as to the importance and necessity of establishing and maintaining quarantine stations under the auspices and control of the Board at Hampton Roads, Sapelo Sound, and Ship Island, it is subject of regret that, owing to recent legislation by Congress, it has not been possible to carry out those views except in a very partial manner.

The funds at the disposal of the Board have necessitated, in the case of Hampton Roads, a temporary abandonment of a national quarantine, substituting therefor aid to the local authorities by the loan of a barge purchased and equipped as a floating hospital at a cost not exceeding $6,000. This was found to be less expensive, and in all respects much better than to repair and fit the hulk Savannah lying at the navy-yard at Portsmouth, which, at the request of the Board, had been courteously granted for its use by the Secretary of the Navy.

For a like reason a temporary arrangement has been made at Sapelo Sound station, by the use of hospital tents on the southern end of Blackbeard Island, and by the purchase of a steam-launch for boarding vessels.

The erection of a hospital, warehouse, and wharf at Ship Island had already proceeded so far before any question arose as to make it inexpedient to alter the original plans of the Board in respect to that important station. In like manner the purchase of three steam-launches for the Mississippi River stations at Cairo, Memphis, and Vicksburg, and of a sanitary patrol steamboat to carry medical supplies and disinfectants at short notice to points on the river not directly accessible by means of railroads, had been contracted for at an early period of the spring.

This provision for aiding State and municipal boards of health in preventing the dissemination of the seeds of contagious and infectious diseases, in conformity with the requirements of section 3, act approved June 2, 1879, is considered by this Board to be an indispensable means of effecting that end. It has accordingly prepared for this river inspection service two somewhat elaborate codes of rules and regulations, one set to be enforced in the absence of yellow fever or cholera in the Mississippi Valley, the other to be enforced where yellow fever exists, at or in the vicinity of any port or place on the Mississippi River, as follows:

MISSISSIPPI RIVER INSPECTION SERVICE.

In accordance with the recommendations of the various State boards of health and of the sanitary council of the Mississippi Valley, the National Board of Health has established its river inspection service for the purpose of preventing the introduction and spread of epidemic, contagious, or infectious diseases along the Mississippi River, and of avoiding unnecessary obstruction to travel and traffic during the prevalence of such diseases.

The experience of 1879 showed that such inspections secured an improved sanitary condition of steamboats, barges, and other vessels; created in threatened communities such a degree of confidence as led to the abandonment of conflicting and onerous quarantine regulations; and prevented the spread of disease along the river, although yellow fever existed at several places in the valley.

The service provides a continuous sanitary supervision of vessels in transit on the Mississippi River, between New Orleans and Cairo, during the summer months; such supervision being exercised through a corps of inspectors acting under uniform rules and regulations. The equipment of the service embraces—

A. Three intermediate inspecting stations, located as follows:

No. 1.—Near Vicksburg, Miss.

No. 2.—Near Memphis, Tenn.

No. 3.—Near Cairo, Ill.

These stations are designated by yellow flags during the day, and by yellow lights at night, and are provided with—

B. Steam-launches and yawls for the use of the inspectors in boarding boats arriving in the vicinity of their stations; and with—

C. Suitable locations (1) for the cleansing, disinfection, and other necessary treatment of *foul* or *infected* boats; (2) for the hospital treatment of the sick from such boats; and (3) for the temporary accommodation of other persons from such boats. There is also—

D. A sanitary patrol-boat for the use of the chief inspector in supervising the conduct of the service generally, and for the prompt conveyance of relief to isolated communities during epidemics.

During the last inspection season it was found possible to conduct this service with little or no delay, expense, or annoyance to river travel and traffic. With added experience and a better equipment, it is believed that these inspections will prove of still greater utility in protecting the public health and in promoting commercial intercourse.

CODE A.

GENERAL RULES AND REGULATIONS

To be enforced in the absence of cholera or yellow fever in the Mississippi Valley.

1. From and after May 1 of each year, and until the close of the inspection season as announced by the National Board of Health, all steamboats carrying passengers or freight, and all tugs, towboats, and barges departing from the port of New Orleans for Vicksburg or above, should obtain a certificate of inspection (Form 1). The inspector of the Mississippi River service, stationed at New Orleans, shall, upon request of the owner, agent, or captain of such boats, make the inspections and furnish the certificate referred to.

2. Such request should be sent to the inspector, in writing, at least twenty-four (24) hours before the date of departure of the vessel (Form 2).

3. At an hour as near as convenient to the time fixed for departure, the inspector shall make a thorough examination of the boat with reference to the following points:

(*a*) Presence or absence, among passengers, officers, and crew, of dangerous sickness.

(*b*) Character and general sanitary condition of cargo.

(*c*) Condition of boat as to cleanliness of hold and bilge, and presence of rotten wood in hull.

4. On the completion of his examination, the inspector will fill out his record (Form 3) in accordance with the facts, and will furnish the master of the boat with a corresponding certificate (Form 1).

5. If, upon examination, the boat be found to be *foul* or the cargo in an insanitary condition, the inspector will advise suitable treatment.

6. A vessel shall be considered "foul," within the purview of this code—

1. If the hold contains decomposing organic matter of any description, or is wet and unventilated.

2. If the bilge is dirty and gives off offensive odors.

3. If the water-closets and urinals are unclean.

4. If the boiler-deck, texas, or other accommodations for the crew are dirty and badly ventilated.

5. If there is much decaying or rotten wood untreated with zinc-iron, copperas solution, or lime-wash.

6. If the cargo comprises articles or material whose exposure and handling are prejudicial to health by reason of decay and decomposition of organic matter, animal or vegetable. Particular attention should be given to the history of rags, paper-stock, and second-hand textile fabrics—especially clothing and bedding—composing cargo; as also all articles from tropical ports, and to the condition of fruits, vegetables, or other articles liable to decomposition.

7. The necessary cleansing and disinfection of a foul boat should be done by the crew of the boat under the supervision of the inspector. Until this is completed and the sanitary condition of the boat is satisfactory he will either withhold the certificate or, in his discretion, indorse the same in accordance with the facts.

8. Boats arriving from below at the ports of Vicksburg, Memphis, or Cairo, without having passed examination at the intermediate inspection station or stations, will not be allowed by the local authorities to land passengers or freight, nor to have any intercourse with said ports, until they shall have returned to the nearest station and there complied with the requirements of this code.

9. On nearing an inspection station the boat should give her usual signal (by whistle), and should "slow up" opposite the station until her signal is responded to. When practicable the boat will be boarded in the stream by the inspector from his launch or yawl; but when necessary the vessel shall land at the station. The signal requiring a vessel to land will be made by dipping the station-flag, or (if at night) by waving a yellow light.

10. After examining the original certificate, the inspector will ascertain what, if any, changes have been made in the *personnel* or cargo since the last inspection; and will then make such examination of the boat as may be necessary to determine her present sanitary condition—being governed by Rule 5, *et seq.*, so far as applicable, in the treatment of a foul vessel. He will indorse the results of his inspection (and his action, if any) upon the original certificate, and make a record of the data called for in Form 3.

11. Boats (as described in Rule 1) departing northwise from, or entering the Mississippi River at, any point above New Orleans during the inspection season should be inspected at the nearest inspection station above such point, and furnished with certificates (Form 1), and in all other respects treated in the same manner as vessels from New Orleans.

12. Any boat, not included or defined in the above rules, may be boarded and inspected at any station in the discretion of the inspector; and if found so foul or infected as to be dangerous to health, she shall be treated in accordance with Rules 5 and 8. In the event of refusal to cleanse or disinfect, as required, the inspector will at once notify—by telegraph, if necessary—the authorities of ports which might be endangered by intercourse with such boat. Refusal to permit boarding and inspection will be deemed *prima facie* evidence of such a suspicious condition as to warrant exclusion; and notice, as above, shall be given in such cases.

13. At the port of departure, as well as at the intermediate sta-

tions, inspectors will endeavor to discharge their duties with the least possible delay or hinderance to the boat. To this end, inspectors above New Orleans will, when practicable, make their examinations while the boats are under way, the inspection launch or yawl accompanying the boat as far as may be necessary for this purpose.

14. No fee, charge, perquisite, or emolument whatsoever shall be received from boats inspected, nor from the persons thereon, by the inspector or any other person connected with this service. Actual cost of disinfectants necessarily used or furnished for a foul or infected boat shall, however, be defrayed by the master or owner of such boat; and the inspector will, in all cases, receipt to said master or owner for any sum or sums thus received. (Form 4.)

15. Inspections of south-bound boats may be provided for hereafter, when in the judgment of the NATIONAL BOARD such inspections are deemed necessary for the protection of the lower valley from the introduction of contagion or infection from above. Under such circumstances needed modifications of this code will be duly promulgated by the BOARD.

16. Inspectors will make weekly reports on the blanks furnished for that purpose (Form 3), and address the same to the *Secretary of the National Board of Health, Washington, D. C.*

CODE B.

RULES AND REGULATIONS.

To be enforced when yellow fever exists at or in the vicinity of any port or place on the Mississippi River.

SECTION I.—AT THE PORT OF DEPARTURE

1. When a port or place on the Mississippi River is declared by the National Board of Health to be infected by yellow fever, and commercial intercourse is to be kept up with such port or place, an inspector or inspectors will be detailed for duty to carry out the provisions of this code.

2. No steamboat or vessel of any kind shall leave such infected port for any other port or place in the United States without complying with these rules.

3. The master or owner of any boat about to leave an infected port shall notify the inspector, in writing, at least twenty-four (24) hours before the time set for taking on cargo or for receiving passengers or baggage (Form 5).

4. Prior to the time appointed for receiving passengers and cargo the inspector will make a thorough examination of the boat and her officers and crew. If she is found to be in good sanitary condition, clean and dry, free from untreated decaying wood, and from all known sources or suspicion of contagion or infection, and if there be no sickness among the officers and crew, the inspector will issue his permit to receive passengers and cargo (Form 6). Until said permit is issued, no passenger nor article of baggage or of cargo should be received on board.

5. Careful inquiry will be made as to all persons engaged on the boat in any capacity, and if it shall be found that any one of them has been exposed to the infection of yellow fever, or has brought on board anything suspected of being infected, such person and such thing shall be removed from the boat, the thing disinfected and the person kept under observation for a period of not less than five (5) days, unless he presents satisfactory evidence that he has been protected by a previous attack of yellow fever.

6. The attention of the captain or master will be directed by the inspector to the personal cleanliness of the crew, to the condition of their quarters, and to their food and drinking-water. If any one on board falls sick during the stay in port, he should be immediately removed to hospital.

7. None of the crew should be permitted to sleep on deck at night during the sickly season, and this should be guarded against especially while the boat is lying at malarious or infected places.

8. In no case should any passenger or article of baggage or of cargo be taken on board until the inspection above directed has been made and the sanitary condition of the boat has been found satisfactory. In case of violation of this rule, the inspector may withhold his certificate.

9. Neither persons nor things of any description, known or suspected to be infected, shall be received on board; and, during the loading of the boat and up to the time of departure, the inspector shall remain on duty to note the reception of any such suspected or infected person or thing.

10. Every passenger leaving an infected port or place shall obtain from the local health authorities a personal certificate of freedom from contagion or infection (Form 7). On presentation of such certificate, the inspector will examine the passenger, and, if satisfied, he will fill out the certificate of the National Board of Health (being part of Form 7), and will make a record of the information called for in Form 8, a duplicate of which will be furnished to the vessel.

11. Articles known or suspected to be infected shall not be received as cargo; and the inspector may, in his discretion, require the owner or shipper of any article or package offered for transportation to sign the declaration and agreement (Form 9).

12. Whenever a steamboat or other vessel is found to be infected, it shall proceed to the nearest quarantine station, or to some isolated location, there to be cleansed and disinfected. In the event that no quarantine station or suitable location is near at hand, or should the master or captain of the boat refuse to comply with these rules and regulations, the inspector will telegraph the facts to the nearest inspection station, and to the health authorities of the intermediate ports or places at which the boat or vessel might attempt to land.

13. When the National Board of Health declares a port to be *dangerously infected*, steamboats or vessels shall be disinfected within twelve (12) hours before departure therefrom; and shall transfer passengers, baggage, and cargo at a point indicated in the special instructions issued to meet such emergencies.

14. The foregoing rules having been complied with, and the passengers and cargo being all on board, the inspector will furnish the captain or master with a bill of health (*Form* 10) certifying the precautions which have been taken and the danger to be apprehended, if any, from the boat, her passengers, officers, crew, or cargo.

SECTION II.—DURING THE VOYAGE.

1. It is especially enjoined upon captains or masters, and other officers, of boats plying upon the Mississippi River during the existence of an epidemic, that they secure the utmost attainable cleanliness in every part of their boats. The bilge should be pumped out every day, and fresh water run in until it is discharged clean and free from odor and discoloration; the hold should be well ventilated, and all refuse matter of every description should be promptly disposed of; all decaying wood should be scraped and painted with zinc and turpentine until it is completely saturated; lime-wash and copperas or zinc-iron should be freely used in the hold and bilge, on and about the boiler-deck and in water-closets and urinals; soap and hot water should be freely used; cabins, state-rooms, and "texas" should be sunned and aired at least six hours each day, weather permitting, as well as all clothing, bedding, carpets, and upholstered furniture. Sun and air are the best, as well as the cheapest, disinfectants. Freely and frequently expose every possible portion of the vessel and its contents to their action, and supplement this by scrupulous and thorough cleanliness.

2. Should sickness make its appearance on board, a sick-bay or hospital should be established as near the stern of the boat as possible, and preferably upon the boiler-deck. The patient must be removed at once to this place, the necessary attendants appointed, and all other persons rigidly excluded from the vicinity of the sick. The attendants must be confined to the hospital quarters and not allowed to mingle with others of the passengers or crew.

3. Immediately after the removal of the patient to the sick-bay, his state-room and its contents must be disinfected with sulphurous acid gas. This is done by burning a couple of pounds of coarsely powdered brimstone in an iron vessel upon the floor of the room—proper precautions being taken against accident by fire. The room must be kept tightly closed after the brimstone is ignited, and not opened again until arrival at the inspection station. At least one room on either side of this room must be vacated during the rest of the trip.

4. During the existence of yellow fever, *all cases of fever* are to be regarded with suspicion. If such cases occur during a voyage, they must be isolated and the same precautions taken as if they were known to be yellow fever.

5. The master or captain shall keep, or cause to be kept, a record of any sickness which may occur on board during the trip. Such record shall set forth the name of each sick person, the hour and day when taken ill, and the symptoms, together with the changes in his or her condition during the morning, afternoon, and night of each day. It shall also state what precautions have been adopted and carried out. This record shall be presented to the inspector on arrival at the station.

SEC. III.—AT LANDING PLACES AND INSPECTION STATIONS.

1. Upon the arrival of a boat from an infected port near, the bill of health (Form 10), and a statement from the captain (Form 11), shall be submitted to the local health authority, under such precautions as may be deemed necessary. It is recommended that this be done at some convenient place not nearer than one mile from the limits of the port, and that the bill of health and the captain's statement be examined before boarding the boat.

2. If, upon examination, the bill of health and the captain's statement are found to be in proper form and satisfactory, the boat shall then be boarded and examined; and if her condition and that of her cargo, passengers, officers, and crew, be found to correspond with the representations in said bill of health and statement, and there be found no sickness of a doubtful or suspicious nature on board, the boat will be authorized to land and to have free intercourse with the port or place; subject, however, to such additional requirements as may be prescribed by the local authorities, and not in conflict with these rules and regulations.

3. Until authorized as above, no boat clearing from, or having touched at, an infected port shall land at any other port or place; and this regulation will be enforced by such measures (of fine and penalty) as the local authorities may decree.

4. When suspicious sickness is found on board, or the condition of the boat or its contents (persons or things) is, in any other respect,

adjudged to be dangerous to the public health, she shall proceed forthwith to the nearest inspection station for treatment. Local authorities cognizant of the movements of such boat will telegraph the facts to the nearest inspection station and to adjacent ports.

5. A boat approaching an inspection station should give her usual signal (by whistle), and "slow up" until her signal is responded to. When practicable, the vessel will be boarded in the stream by the inspector, from his launch or yawl; but, when necessary, the vessel shall land at the station. The signal requiring a vessel to land will be made by dipping the station flag by day, and by waving a signal light at night.

6. After examining the bill of health and the captain's statement, the inspector will ascertain what, if any, changes have been made in the *personnel* and cargo of the vessel since the last inspection, and will then make such critical examination of the vessel as may be necessary to determine her present sanitary condition.

7. If the vessel be found free from doubtful or suspicious sickness, clean, and in good sanitary condition, the inspector will so indorse the bill of health, and she will be authorized to proceed upon her trip.

8. Especial attention will be paid to the examination of such passengers, baggage, cargo, or freight as may have been taken on board subsequent to the last inspection, and the inspector will note all additions of passengers upon the passenger list (Form 8), and will furnish them with personal certificates (Form 12).

9. If the vessel is found to be infected, she will be at once removed to a suitable location, and treated as follows:

(*a*) The sick will be removed to hospitals for treatment. Other passengers, and the unprotected or susceptible among the officers and crew, will be removed to quarters prepared for their reception. Only "protected" persons (in the sense of those who have previously had an attack of typical yellow fever) shall be allowed on the vessel until after she has been disinfected.

(*b*) No article of clothing, bedding, or personal baggage of any description from the vessel shall be taken into hospitals or quarters until such article has been thoroughly disinfected.

(*c*) After the removal of persons and baggage, the boat shall be disinfected by means of sulphurous acid gas, as thoroughly as possible, without disturbing the cargo. The crew of the boat shall then discharge the cargo, which shall be stored in such manner as to insure its freest exposure to the open air consistent with necessary protection.

(*d*) When the cargo has been removed, the vessel shall be thoroughly cleansed in every accessible part, again disinfected and ventilated as the inspector may deem necessary. After the preliminary disinfection (prescribed in Article "*c*"), all work in removing and handling cargo and in cleansing and care of boat should be performed by the crew under the direction of the inspector.

10. Until this process of discharge of cargo and purification of boat, as above directed, has been completed to the satisfaction of the inspector (as shown by his certificate to that effect) there shall be no communication between the boat and the shore, or with other vessels, except by the written permit of the inspector, and then only in the manner and for the purpose specified in said permit.

11. Those sick with yellow fever shall not be allowed to leave the hospital until in the judgment of the inspecting officer they can do so without danger to themselves or others.

12. Persons under observation shall be detained for at least five (5) days from the time of last exposure to the contagion or infection of yellow fever. If the disease appears among such persons the sick shall be removed to hospital, and a new locality for observation selected with such precautions, by way of disinfection, &c., as the inspector may deem necessary to prevent the transportation of the infection to the new site.

13. No arbitrary period of detention, beyond five (5) days from last exposure of unprotected persons, will be enforced. The vessel will be permitted to depart, and the cargo released as soon as the inspector deems it safe to do so with reference to the public health.

14. "Protected" persons, whether among the passengers, officers, or crew, shall be exempt from the five days' detention for observation, and may be allowed to depart at any time after the necessary precautions have been taken with regard to their baggage, clothing, and other effects, as well as to themselves in person. The inspector shall be the judge of the evidence of such "protection," and will exercise due caution in the use of this discretionary power.

15. When the boat and cargo are released the inspector shall issue his certificate, reciting the facts in relation to said boat, his action thereupon, and his belief that the boat and cargo are free from infection, and may proceed without danger or menace to the public health.

16. No person taken from an infected boat at the inspection station shall depart therefrom without a certificate from the inspector authorizing him or her to proceed, as being free from infection or the probability of conveying the same.

17. Persons employed at an inspection station, having been brought in contact with an infected boat, shall not be permitted to leave such station until their clothing has been washed and disinfected.

18. It shall be the duty of the inspector to take such other measures of precaution, in addition to the foregoing, as he may deem necessary or expedient for the protection of the public health.

19. No boat nor passenger having the proper certificates showing that these rules and regulations have been complied with, should be detained by other health authorities, except for sufficient cause.

20. The foregoing regulations apply to all boats carrying passengers or freight, including all tow-boats, tugs, barges, and canal-boats plying upon the Mississippi River south of Cairo, Ill.

[Form 1.]

NATIONAL BOARD OF HEALTH—RIVER INSPECTION SERVICE, 1880.

Certificate of inspection of the ———, 1880.

EXPLANATIONS.

1. The master or captain of the boat will fill up and sign blank A.
2. Every person on board at time of inspection must be accounted for, either among the passengers, officers, or crew.
3. Only the following articles of cargo need be specified: *Coffee, sugar, fruits*, other articles from tropical ports, *second-hand bedding and clothing, rags*, and *paper stock*.
4. If the vessel is a tow-boat, the number, names, and tonnage of her barges will be given in the space for cargo. If the barges are loaded, articles of cargo enumerated above will be specified.

—

DECLARATION OF CAPTAIN, A.

[To be sworn to if required.]

PORT OF ———,
———, 1880.

I do hereby declare that the following statements concerning the vessel herein named (whereof I am captain or master,) and concerning her present trip, are correct and true to the best of my knowledge and belief, to wit: The ———, built in the year ——, burden ——— tons, leaves ——— this —— day of ———, 1880, bound for ———, carries — officers, —— crew, —— cabin, and —— deck passengers, no one of whom is known or suspected to have yellow fever, cholera, small-pox, or plague, or to have been recently exposed to either of these diseases. Her cargo comprises

....

....

——— ———,
Captain.

Sworn and subscribed to before me this — day of ——, A. D. 1880.

——— ———,
Inspector.

—

NATIONAL BOARD OF HEALTH—CERTIFICATE OF INSPECTION, B.

No. ——.
PORT OF NEW ORLEANS, LA.,
——— —, 1880.

I certify (1) that I have this day inspected the ———; (2) that I find her sanitary condition satisfactory; (3) that her passengers, officers, and crew are apparently free from contagion and infection; (4) that the *Rules and Regulations of the National Board of Health* have been complied with ———; and (5) that the character of her cargo is unobjectionable ———.

The vessel is hereby authorized to proceed upon her trip.

——— ———,
Inspector.

—

NATIONAL BOARD OF HEALTH—CERTIFICATE OF INSPECTION, C.

No. ——.
STATION No. 1, *near* VICKSBURG, MISS.,
——— —, 1880.

I certify that I have this day inspected the ———, and find that the statements made in the declaration of the captain (A), as also those numbered ———, in the preceding certificate (B) agree with the present condition of the vessel, her passengers, officers, crew, and cargo, with the following exceptions:

....

....

The *Rules and Regulations of the National Board of Health* having been fully complied with, and the sanitary condition of the vessel, her passengers, officers, crew, and cargo being satisfactory, she is hereby authorized to proceed upon her trip.

——— ———,
Inspector.

NATIONAL BOARD OF HEALTH—CERTIFICATE OF INSPECTION, D.

No. ——. { STATION NO. 2, *near* MEMPHIS, TENN., ——— —, 1880.

I certify that I have this day inspected the —— ——, and find that the statements made in the declaration of the captain (A); those numbered ———, in certificate B, and those in certificate C, agree with (remainder of form same as that of C).

—

NATIONAL BOARD OF HEALTH—CERTIFICATE OF INSPECTION, E.

No. ——. { STATION NO. 3, *near* CAIRO, ILL., ——— —, 1880.

I certify that I have this day inspected the —— ——, and find that the statements made in the declaration of the captain (A); those numbered 2, 3, 4, 5, in certificate B, and those in certificates C and D agree with (remainder of form same as C).

——

[Form 2.]

NATIONAL BOARD OF HEALTH—RIVER INSPECTION SERVICE.

PORT OF NEW ORLEANS, LA., ———, 1880.

The inspector of the National Board of Health—River Inspection Service—is hereby notified that the ——— is on berth at ———, and will leave for ——— at — o'clock — m., ———, 1880.

——— ———, *Captain.*

——

[Form 3.]

NATIONAL BOARD OF HEALTH—RIVER INSPECTION SERVICE, 1880.

Record of inspections made at ——— during the week ended ———, 1880.

——— ———, *Inspector.*

NOTE.—Inspectors at intermediate stations will note in their records (under the heads of "Found on board" and "Cargo") any changes made during a trip in passenger list or cargo. They will specify (under the head of "Remarks") what, if any, inspections have been made during the trip of each vessel prior to her arrival at their respective stations, and note any special features of such inspections.

They will also (under the same head) state fully what measures of cleansing or disinfection may have been found necessary and enforced by them.

—

[Form 3 continued.]

NATIONAL BOARD OF HEALTH—RIVER INSPECTION SERVICE.

Record of inspection No. —, made ———, 1880, — o'clock — m.

——— ———, *Inspector.*

Inspected ———; built ——; tonnage ———; ——— ———, captain.

Bound from ———, ———, 1880, to ———.

Found on board: — officers, — crew, — cabin, — deck passengers ———.

Cargo comprises the following articles duly specified on certificate: ———

Condition of vessel: Hold, ———; bilge, ———; water closets and urinals, ——— ; decaying or rotten wood, ———; quarters for crew, ———.

Remarks: (four blank lines.)

——

[Form 4.]

NATIONAL BOARD OF HEALTH—RIVER INSPECTION SERVICE, 1880.

STATION NO. —, *near* ———, ——— 31, 1880.

Received ...... from .... $ $\frac{}{100}$ for ....

Received from ——— ———, captain of the ——, the sum of —— dollars, in full for disinfectants (kind and quantity specified on the back hereof) furnished for the cleansing and disinfection of said vessel.

——— ———, *Inspector.*

$ $\frac{}{100}$

[Form 5.]

NATIONAL BOARD OF HEALTH—RIVER INSPECTION SERVICE, 1880.

Port of (1) ——— ———, ———., ———, 1880.

The inspector of the National Board of Health, River Inspection Service, is hereby notified that the (2) —— ——, whereof the undersigned is Master, is on berth at (3) ———, for (4) ———, and will be ready to receive passengers, baggage, and freight on board at (5) ————, 1880.

(6) ——————, *Master.*

NOTE.—Fill out blanks with (1) name of port and date of notice; (2) name of vessel; (3) location of berth; (4) place of destination; (5) hour, a. m., or p. m., and day of week and of month of departure; (6) signature of Master, for whom the clerk of the boat may sign.

Indorsement:

Form 5. 1880.

NATIONAL BOARD OF HEALTH.

RIVER INSPECTION SERVICE.

Notice to Inspector.

——

[Form 6.]

NATIONAL BOARD OF HEALTH—RIVER INSPECTION SERVICE, 1880.

Port of ——— ———, ——, ————, 1880.

I have this day inspected the ————, ———, Master, bound for ———, ———, from this port; and do hereby certify that her sanitary condition ———; that the hold ———; that the bilge ———; that there is ——— decaying wood ———; and that her officers and crew show ——— symptoms of yellow fever, and are believed ——— to have been exposed to that disease within the past ——— days.

The said vessel, being hereby pronounced free from all known sources of contagion or infection ———, is authorized to receive passengers, baggage, and cargo, in accordance with the rules and regulations of the National Board of Health.

——— ———, *Inspector.*

Indorsement:

Form 6. 1880.

NATIONAL BOARD OF HEALTH.

RIVER INSPECTION SERVICE.

Permit to Receive Passengers and Cargo.

——

[Form 7.]

NATIONAL BOARD OF HEALTH—PASSENGER'S CERTIFICATE AND INDORSEMENTS, 1880.

[Size 6 inches wide, 10 inches long, to fold twice, making 6 pages.]

CERTIFIED STATEMENT OF PASSENGER.

(Place.) ———, ———, (Date.) ——— —, 1880.

I do hereby certify that I have not, within the past ——— days, been afflicted with ———, nor in any manner exposed to its contagion or infection; that I have resided during all of said period at No. —— ——— street, and that I desire to proceed by river to ———.

In witness whereof I have hereunto set my hand and seal the day and date above written.

[L. S.] ——— ———.

VERIFICATION OF PHYSICIAN.

——— ———, the person whose signature is appended to the above certificate, is personally known to me, and I believe the statements made in said certificate to be true and correct. I further believe [him or her] to be free from contagion or infection, and that [he or she] may proceed upon [his or her] journey without injury or danger to the public health.

——— ———, *M. D.*

———, ———, ——— —, 1880.

LOCAL AUTHORIZATION.

BOARD OF HEALTH OF ———, ———, ——— —, 1880.

——— ———, M. D., a reputable practicing physician, having proper opportunities for knowing the present conditions affecting the

public health, and believed to fully recognize the importance of preventing the spread of the existing epidemic, is hereby authorized and empowered to verify the foregoing certificate.

——— ———,
President Board of Health.

NOTE.—In the absence of a board of health, the chief municipal officer will issue this authorization.

I hereby certify, after personal examination, that ——— ———, named in the within certificate, is not now affected with ———; that all rules and regulations of the National Board of Health relating to the departure of passengers from infected towns and places have been complied with in [his or her] case; and that [he or she] may, without danger to the public health, proceed as a passenger on the ———, to ———, ——.

——— ———,
Inspector, N. B. H.

———, ——,
——— ——, 1880.

INDORSEMENTS OF SUBSEQUENT INSPECTORS.

——— ———. ——— ———.
——— ———. ——— ———.
——— ———. ——— ———.

[Form 8.]

NATIONAL BOARD OF HEALTH—RIVER INSPECTION SERVICE, 1880.

Passenger list of the —— ——, ——— ———, master, from the port of ———, ——, this —— day of ——, 1880, to ——— ——:

Name.	Last residence.	Where to.	Name of physician verifying certificate.

NOTE.—If the sex is not indicated by the name, prefix *Mrs.* or *Miss* in the proper cases. Add the letter "c" after the names of colored persons. The number, street, and city or town will be given under the head of "*Last residence.*" The inspector will add, after the last name, the following: ***Personally examined the above-named passengers, and authorized their departure.***

(Signature.)
Inspector.

(Indorsement:)

Form 8. 1880.

NATIONAL BOARD OF HEALTH.

RIVER INSPECTION SERVICE.

Passenger List.

[Form 9.]

DECLARATION AND AGREEMENT.

PORT OF ———————, ——,
———, 1880.

I, ——— ———, a resident of ———, ——, and being the legal and rightful owner custodian (1) of certain property, to wit: (2)

....

....

and being desirous of shipping the same, by the ———————, from this port to ———, ——, do hereby declare that said described property has not been exposed to any contagion or infection of ——— ——— within the past —— days, to the best of my knowledge and belief, and that the contents of the packages are as herein described.

I do, further, hereby agree to submit said property to the *Rules and Regulations* of the NATIONAL BOARD OF HEALTH relative to the spread of epidemic, contagious, or infectious diseases.

In witness whereof I have hereunto set my hand and seal at the port and on the day and date above written.

[L. S.] ——— ———.

NOTE.—(1) Strike out the superfluous word.—(2) Describe the contents of packages (boxes, barrels, bales, etc.), and give the shipping marks and address.

(Indorsement:)

Form 9. 1880.

NATIONAL BOARD OF HEALTH.

RIVER INSPECTION SERVICE.

Declaration and Agreement of Shippers.

[Form 10.]

NATIONAL BOARD OF HEALTH—RIVER INSPECTION SERVICE, 1880.

BILL OF HEALTH.

I do hereby certify that I have this day personally examined the vessel herein named, and find the following to be the essential facts bearing upon the relation of said vessel to the public health:

Name and description: ———————.
Built at ———————, ———; in the year 18—.
Tonnage: ———. Destination: ———.
Name of captain: ———.
Total No. officers and crew, (1) ———; cabin passengers (2)———; deck passengers (2) ———. Total souls on board ———.
Cargo: (3) ———.
Condition of hold: ———; of bilge: ———; of passenger's accommodation: ———; of crew's quarters: ———; of water-closets and urinals: ———; of other specified portions of the vessel: ———.
Condition of persons on board: ———.

The *Rules and Regulations* of the NATIONAL BOARD OF HEALTH, relative to the spread of epidemic, contagious, or infectious diseases at the port of departure, having been fully complied with, and the vessel and her contents being believed to be free from contagion and infection, she is hereby authorized to proceed to her port of destination, subject to the further rules and regulations governing vessels in transit and on arriving at landing places and inspection stations.

In witness whereof, I have hereunto set my hand and seal at the port of ———————, ———, this ——— day of ———, A. D. 1880.

[L. S.]
——— ———,
Inspector, N. B. H.

NOTE.—(1) All persons employed on board, in whatever capacity, must be accounted for. (2) The names of all passengers must appear on the *Passengers' List, Form* 8. (3) Articles of cargo shipped under *Declaration and Agreement, Form* 9, must be mentioned on this BILL OF HEALTH.

(Indorsement:)

Form 10. 1880.

NATIONAL BOARD OF HEALTH.

RIVER INSPECTION SERVICE.

Bill of Health.

[Form 11.]

NATIONAL BOARD OF HEALTH—RIVER INSPECTION SERVICE, 1880.

ON BOARD ———————
NEAR ———, ———.

I, ——— — ———, master of the above-named vessel, do hereby certify that there is no yellow fever on board, and no infected article or cause of contagion of any kind, to the best of my knowledge and belief. All the *Rules and Regulations* of the NATIONAL BOARD OF HEALTH, relative to the prevention of the spread of epidemic, contagious, and infectious diseases, have been complied with.

Since last being inspected I have made the following landings:

....

In witness of the truth of the foregoing statement I have hereunto set my hand and seal, this ——— day of ———, A. D. 1880.

[L. S.]
——— ———,
Master.

(Indorsement:)

Form 11. 1880.

NATIONAL BOARD OF HEALTH.

RIVER INSPECTION SERVICE.

Statement of Captain or Master.

(Form 12.)

NATIONAL BOARD OF HEALTH—RIVER INSPECTION SERVICE, 1880.

INSPECTION STATION No. —, *near* ———,
——— —, 1880.

I hereby certify that the bearer of this certificate, ——— ———, arrived at this station on the ———; that the passenger-list of said vessel shows [him or her] to have been received on board at ———, which place is now free from yellow fever; that [he or she] is not now affected with that disease; is believed to be free from contagion or infection; and may, without danger to the public health, proceed to ———.

——— ———,
Inspector.

(Indorsement:)

Form 12. 1880.

NATIONAL BOARD OF HEALTH.

RIVER INSPECTION SERVICE.

Way Passenger Service.

RULES AND REGULATIONS.

For the conduct of railway travel and traffic in regions exposed to or infected with yellow fever.

GENERAL RECOMMENDATIONS AT ALL SEASONS OF THE YEAR.

1. The depots, buildings, and surroundings should be kept clean, the grounds well drained, and free from stagnant water and decomposing organic matter; the water-closets and privies thoroughly clean in every part, and free from offensive odors; the vaults of privies emptied often enough to prevent any large accumulation of excrement or offensive matter, and kept disinfected by the use of saturated solutions of the sulphates or chlorides of iron or zinc, in sufficient quantity to remove all offensive odors.

2. The road-beds and tracks of railroads should be kept free from filth and impurities. It is especially desired that this rule be observed in respect to all sidings near stations or towns.

3. The upholstered seats of passenger and sleeping cars, and the mattresses, pillows, blankets, curtains, and carpets of sleeping-cars should be thoroughly whipped or beaten (in the open air so far as practicable) and brushed free from all dust, and thoroughly aired and sunned at the end of each trip.

4. So far as practicable, woolen upholstery, curtains, and carpets should be dispensed with in passenger, sleeping, and parlor coaches on all lines south of the Ohio River between April 1 and November 1, each year. During this period, if seats must be used which are upholstered with woolen stuffs, they should be protected by linen covers, which should be washed at the end of each trip.

5. Especial attention should be paid to the condition of the closets, as also the water supply for drinking purposes.

6. All railroad cars should be thoroughly ventilated at all times.

RULES AND REGULATIONS.

Recommended to be enforced by State or municipal authorities during the existence of yellow fever.

1. Every train leaving an infected city, town, or other place shall be inspected by a competent medical man, who shall give to the conductor of said train a certificate of the results of his inspection in accordance with *Form No.* 4, appended hereto.

2. It shall also be his duty to furnish certificates to each passenger, in accordance with *Form No.* 3, appended hereto, and no passenger shall be permitted to leave an infected place without such certificate. No person having fever shall be allowed to take passage on such train.

3. All cars leaving such place shall be thoroughly cleansed, and fumigated with sulphurous acid gas by burning 18 ounces of sulphur for every 1,000 cubic feet of space, closing the car tightly for six hours prior to leaving.

4. No upholstered car shall be allowed to leave a dangerously infected place; but passengers shall be carried from such place to the *transfer station* (provided for in *Rule* 6) in open pavilion cars, or cars furnished with wooden seats and with such facilities for ventilation as will insure thorough exposure to the open air during the transit.

5. All baggage shall be thoroughly disinfected at or near the station before leaving.

6. At a point not less than five (5) miles, and as near this distance as practicable, from the point of departure from an infected place, there shall be an entire transfer of passengers and baggage to other open pavilion cars of the same description as those prescribed in *Rule* 4, which cars shall not enter an infected district except as provided for in *Rule* 16.

7. The transfer train from an infected place, after having disembarked its passengers and baggage at the transfer station, shall withdraw, with its conductor and crew, at least one mile before the outbound train will be allowed to back down to the station. Both trains must not be permitted to be at the station at the same time, and the officer in charge of the transfer will allow no communication between the crews of the respective trains.

8. This transfer shall be made in the open air, under the supervision of a medical officer, and as far from a habitation as possible, and no person with fever shall be allowed to proceed. Neither shall any person be allowed to proceed without the certificate (*Form* 3) prescribed by *Rule* 2.

9. The medical officer at the transfer station shall carefully examine the conductor's certificate (*Form* 1), and the certificate of each passenger (*Form* 3), and shall fill up the blanks in the transfer station certificate attached to *Form* 3, and furnish to the conductor of the outbound train his certificate (*Form* 2) duly made out to accord with the results of his examination.

10. The pavilion cars from the transfer station may be attached to the rear of any regular train at a point not less than five (5) miles beyond the station, and passengers and baggage from such pavilion cars may enter the regular passenger and baggage cars of such regular train after having been carried in the pavilion cars for a distance of not less than fifty (50) miles from the infected place, but not sooner.

11. No sleeping-car shall be allowed to leave a dangerously-infected place, nor shall any sleeping-car approach nearer such place than a point five (5) miles beyond the transfer station.

12. In case of suspected infection of a passenger-car or of a sleeping-car, such car, including all the upholstery, cushions, curtains, mattresses, &c., shall be thoroughly disinfected, under the supervision of a medical officer, and shall be exposed to the open air for at least twenty days before being again used.

13. All freight shall be transferred at a point not less than five (5) nor exceeding fifty (50) miles from the point of departure, and the cars from which such freight has been transferred shall not proceed farther on the road, but shall be returned to the point of departure. The freight-cars, after unloading, shall be thoroughly cleansed by scrubbing, disinfected, and ventilated.

14. Mail matter and mail bags shall be heated to a temperature of two hundred and fifty (250) degrees Fahrenheit, or should be otherwise disinfected before they are sent from infected places.

15. If yellow fever infect a place situated upon a line of railroad, trains of all kinds may be permitted to pass through without stopping, and at a speed of not less than ten (10) miles an hour; but they shall not take on passengers from such infected place except as hereinbefore provided—namely, after transit of person and baggage (in such manner as shall secure free exposure to the open air) from the infected place to a point at least five (5) miles distant, where, upon presentation of the proper certificate (*Form* 3), they may be received on the pavilion cars provided for such purpose, but from which they shall not enter the regular cars of the train until after having ridden at least fifty (50) miles from the infected place.

16. No train having a certificate of inspection from a transfer station (*Form* 2), and no passenger having certificate (*Form* 3) duly *viséd* at the proper transfer station, shall be interfered with by any municipal or other local system of quarantine.

17. All persons leaving infected places by other modes of travel than those herein provided for shall be required to obtain certificates according to *Form* 4, appended hereto.

[Form No. 1.]

I hereby certify that train No. —, on the ——— Railroad, ——— ———, conductor, and which leaves ——— at ——— o'clock — m., this day, has complied with all the rules and regulations recommended by the NATIONAL BOARD OF HEALTH for trains leaving infected places.

——— ———, (signature)
Inspecting Officer.

(Name of place.)
(Date.)

[Form No. 2.]

I hereby certify that train No. —, on the ——— Railroad, ——— ———, conductor, has not been nearer the city (or town) of ——— than — miles; that the passengers and baggage thereon were brought to this station in open pavilion cars, and that all the rules and regulations recommended by the National Board of Health for the conduct of railway travel and traffic with infected places have been complied with by this train, which is, therefore, authorized to proceed without further detention.

(Name of transfer station, date, and signature.)

[Form No. 3.]

(Same as "Form No. 2," of 1879.)

[Form No. 4.]

(Same as "Form No. 3," of 1879.)

(Matter on pp. 29, 30, 31, and 32, pamphlet of 1879, unchanged. To "General explanations," on p. 31, add the "Explanations" on p. 4, *ibid.*)

RULES AND REGULATIONS

To be observed and enforced by the health authorities of a place free from infection, having communication with a place dangerously infected with yellow fever.

1. No steamboat or other vessel, or railroad train or other conveyance, or persons, from a place *dangerously infected*, shall be permitted to enter a non-infected place without having certificates of the forms prescribed (see pages 17 and 26), giving evidence that they have complied with the rules and regulations provided for conveyances and persons leaving *dangerously infected* places. Boats, trains, and persons having certificates in proper form that they have been inspected and are free from disease shall be allowed to enter.

2. Inspections to ascertain whether these rules have been observed, and whether it is safe for the conveyances or persons to enter a non-infected place, shall be made outside the limits of such place.

3. Separate accommodations must be provided both for the sick and for the well who are detained for observation.

RULES AND REGULATIONS

Recommended to be adopted and observed when yellow fever is reported or suspected to exist in any town or place in the United States.

GENERAL EXPLANATIONS.

A. During the warm season, in all localities in any way exposed to the contagion of yellow fever, the possibility of its occurrence should never be lost sight of by physicians, and when it is known to be present in any place, the antecedents and diagnosis of every case admitting of doubt should receive special attention.

B. Upon an outbreak of yellow fever, a competent medical officer should be assigned to the locality as health officer, to enforce the following rules and regulations:

1. All physicians shall report to the health authorities with the least possible delay their knowledge or belief of the existence of the first cases of yellow fever, and shall at the same time secure, as far as possible, the isolation of such cases pending the action of the health authorities.

2. Upon the receipt of such report the health authorities shall at once investigate the case, and if it be found to be yellow fever or a case admitting of reasonable doubt, they shall at once have the patient isolated as effectually and completely as possible.

3. In case of the patient's removal, recovery, or death, the premises occupied by him shall be thoroughly disinfected, and the clothing, bedding, and other articles which have been exposed to infection shall be either burned or boiled in water for not less than thirty minutes.

4. When the health authorities of any place shall first discover a case of yellow fever there, they shall report the fact at once by telegraph to the National Board of Health.

5. An attempt should be made to isolate and keep under observation for at least five days all persons who have been in such relation to the first case or cases as to make it possible that they are infected.

6. In general, no place shall be considered *dangerously infected* until at least one case has occurred as a result of infection incubating within the place itself.

7. When a place is declared *dangerously infected* the health authorities should advise, and use every effort for, the removal of all persons liable to yellow fever to a place or places safe from danger of infection. When they can be removed to only a short distance, it is better to locate them in tents in the open air.

ANNUAL MEETING OF THE NATIONAL BOARD OF HEALTH.

The annual meeting of the National Board of Health was held in the city of Washington, D. C., convening on May 4 and adjourning May 10, 1880.

The Board re-elected its former officers, and revised its by-laws and appointed committees, as follows:

BY-LAWS OF THE NATIONAL BOARD OF HEALTH.

1st. The officers of the National Board of Health shall consist of a president, vice-president, and secretary.

2d. There shall be an executive committee, composed of the president, vice-president, secretary, and three other members.

3d. The officers of the Board and the other members of the executive committee shall be elected by ballot at the first annual meeting in each year, the nomination to be by informal ballot.

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First. To preside at all meetings of the Board and of the executive committee.

Second. To call meeetings as provided in the act creating the Board.

Third. To make requisitions upon the Secretary of the Treasury for such sums as may be directed by the Board.

5th. The vice-president shall take the place and perform the duties of the president when absent.

6th. The secretary shall keep the records and conduct the correspondence of the Board and of the executive committee, certify to the correctness of all vouchers for expenditures, and perform such other duties as the Board or executive committee may from time to time direct, and he shall be the custodian of all papers, books, and other property of the Board.

7th. The executive committee shall carry into effect the directions of the Board, and act for it during the intervals of its sessions, reporting such action to the next meeting.

8th. The executive committee is authorized to fill any vacancies in the offices or executive committee occurring in the intervals of the meetings of the Board, such election to hold good until the close of the next meeting of the Board.

9th. No purchases shall be made or expenditures incurred except by order of the Board or of the executive committee, and the executive committee shall not have power to incur any indebtedness beyond the amount of funds authorized by the Board to be drawn by the president, and placed to the credit of the Board with the disbursing clerk of the Treasury Department.

10th. The executive committee shall be considered to be in permanent session, and, in the interval of the regular meetings, any three members, of whom the secretary shall be one, shall constitute a quorum, and be authorized to transact any business, provided there be a concurrent vote. In case of disagreements the secretary shall be required to report the fact to the absent members and solicit an expression of their wishes as to the call of a formal meeting of the whole committee, or as to taking a vote by correspondence.

11th. All bills for salaries and expenses shall be duly certified by a member or inspector of the Board, and audited and approved by the secretary of the Board, who shall keep an accurate record of such vouchers and approvals.

12th. The standing committees of the Board shall be as follows, each to be composed of not less than three members, named by the president, with the exception of that on epidemic and contagious diseases, which shall consist of five members:

1. On epidemic and contagious diseases.
2. On registration and vital statistics.
3. On State, municipal, and local sanitary legislation.
4. On quarantine legislation—State, national, and international.

13th. The regular meetings of the Board shall be semi-annual, in June and December of each year, at a day and place to be fixed by the executive committee.

14th. The president shall call a meeting of the Board whenever five members make in writing or by telegraph a joint request to him to that effect.

THE NATIONAL BOARD OF HEALTH.

PRESTON H. BAILHACHE, M. D., U. S. M. H. S., 240 Md. ave., Balt., Md.
SAMUEL M. BEMISS, M. D., &c., 558 St. Charles st., New Orleans, La.
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STEPHEN SMITH, M. D., &c., 31 West 42d street, New York.
THOMAS J. TURNER, M. D., U. S. N., 1227 M st., Washington, D. C.
TULLIO S. VERDI, M. D., &c., 815 14th st. N. W., Washington, D. C.

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2. *On registration and vital statistics.*—J. S. Billings, R. W. Mitchell, H. A. Johnson.

3. *On State, municipal, and local sanitary legislation.*—H. I. Bowditch, S. F. Phillips, S. Smith.

3. *On quarantine legislation—State, national, and international.*—S. Smith, S. F. Phillips, J. L. Cabell, S. M. Bemiss, P. H. Bailhache.

At the same meeting the Board revised the rules and regulations for securing the best sanitary condition of vessels, including their cargoes, passengers, and crews, coming to the United States from any foreign port where any contagious or infectious disease exists. The rules then, slightly modified, were submitted to the President of the United States, and were approved by His Excellency June 17, and are as follows:

RULES AND REGULATIONS FOR SECURING THE BEST SANITARY CONDITION OF VESSELS, INCLUDING THEIR CARGOES, PASSENGERS, AND CREWS, COMING TO THE UNITED STATES FROM ANY FOREIGN PORT WHERE ANY CONTAGIOUS OR INFECTIOUS DISEASE EXISTS.

[Prepared by the National Board of Health, in accordance with the provisions of an act approved June 2, 1879, entitled "An act to prevent the introduction of infectious or contagious diseases into the United States."]

EXPLANATIONS.

1. The object of the following rules and regulations is to prevent the introduction into the United States of "contagious or infectious diseases."

2. The following diseases are recognized as "contagious or infectious diseases" for the purposes of these rules and regulations, viz: Asiatic cholera, yellow fever, plague, small-pox, typhus fever, and relapsing fever.

3. An "infected" port or place, in the sense of these rules, is a port or place at which either Asiatic cholera, yellow fever, or plague exists, or at which either small-pox, relapsing fever, or typhus fever exists as an epidemic.

4. To secure the "best sanitary condition" of a vessel the follow

ing points should be observed by the owners, agents, or master of such vessel:

A. Exclusion from the vessel, as far as possible, of persons or things known or suspected to be infected.

B. Cleanliness, dryness, and ventilation of the vessel, both preliminary to loading and during the voyage.

C. Disinfection—that is, the destruction or removal of the causes of disease—which includes measures of cleanliness, ventilation, fumigation, &c.

D. The crew shall not be allowed liberty on shore after nightfall in suspected localities. They shall not be allowed to sleep on deck except under awnings. The forecastle shall be well ventilated and kept dry. Both in port and at sea the bilge shall be pumped out each morning and evening, or more frequently if necessary. The utmost cleanliness shall be observed at sea as well as in port. Each seaman should have two suits of underclothing. The clothing and bedding should be aired every clear day. In tropical climates the men should be required to wash their persons and change their underclothing every evening after work while in port, and each working suit should be washed, dried, and aired after a day's use. These regulations as to clothing, airing of bedding, and ventilation should, as far as possible, be observed at sea as well as in port.

RULES AND REGULATIONS.

1. All merchant ships and vessels sailing from a foreign port where contagious or infectious disease exists, for any port in the United States, must obtain from the consul, vice-consul, or other consular officer of the United States, at the port of departure, or from the medical officer—where such officer has been detailed by the President for that purpose—a bill of health in duplicate, which shall be a clean bill or a foul bill, and which shall set forth the sanitary history of said vessel, and that it has in all respects complied with these rules and regulations. A clean bill of health shall be given when neither Asiatic cholera, yellow fever, nor plague exists, and neither small-pox, relapsing fever, nor typhus fever exists as an epidemic at the port of departure, and the condition of the vessel is satisfactory; and in such case it shall be certified that the vessel leaves the port in "free pratique." A foul bill of health shall be given when either Asiatic cholera, yellow fever, or plague exists, and when small-pox, relapsing fever, or typhus fever exists as an epidemic at the port of departure, or where the sanitary condition of the vessel is unsatisfactory, and in such case it shall be certified that the vessel leaves the port in "quarantine."

2. In all cases of doubt as to whether the port is infected, or as to the sanitary condition of the vessel, the bill shall be foul.

3. No vessel shall have more than one bill of health; but if she touches at other ports on the passage, that fact and the condition of those ports as to the existence of contagious or infectious disease shall be indorsed upon the original bill of health by the consul, vice-consul, consular officer, or medical officer of the United States.

4. The bill of health shall be in the form appended. [Form A.]

5. Each consul, vice-consul, consular officer, or medical officer of the United States in a foreign port shall keep himself thoroughly acquainted with the sanitary condition of the port and its vicinity, especially with regard to the existence of contagious or infectious diseases, or epidemics, and shall, upon request of the owner, agent, or master, make, or cause to be made, an inspection of every ship or vessel bound for any port in the United States, and give the bill of health required by these regulations. Vessels carrying a foreign flag shall be inspected, when practicable, in company with the consul or consular agent of the nation to which the vessel belongs.

6. The fee for such inspection shall be such as may be fixed by the Secretary of the Treasury in accordance with law.

7. The certifying officer at the port of departure shall certify whether vessels carrying passengers are provided with the means of carrying out the provisions of section 4257 and 4263 of the Revised Statutes.

SEC. 4257. Every such vessel so employed in transporting passengers between the United States and Europe, and having space according to law for more than one hundred such passengers, shall have at least two ventilators to purify each apartment occupied by such passengers; one of which shall be inserted in the after part and the other in the forward part of the apartment, and one of them shall have an exhausting-cap to carry off the foul air, and the other a receiving-cap to carry down the fresh air. Such ventilators shall have a capacity proportioned to the size of the apartments to be purified, namely: If the apartments will lawfully authorize the reception of two hundred such passengers the capacity of each such ventilators shall be equal to a tube of 12 inches diameter in the clear, and in proportion for larger or smaller apartments. All such ventilators shall rise at least four feet six inches above the upper deck of any such vessel, and be of the most approved form and construction. If it appears from the report to be made and approved, as provided in section forty-two hundred and seventy-two, that such vessel is equally well ventilated by any other means, such other means of ventilation shall be deemed to be a compliance with the provisions of this section.

SEC. 4263. The master of any vessel employed in transporting passengers between the United States and Europe is anthorized to maintain good discipline and such habits of cleanliness among passengers as will tend to the preservation and promotion of health; and to that end he shall cause such regulations as he may adopt for this purpose to be posted up, before sailing, on board such vessel, in a place accessible to such passengers, and shall keep the same so posted up during the voyage. Such master shall cause the apartments occupied by such passengers to be kept at all times in a clean, healthy state; and the owners of every such vessel so employed are required to construct the decks and all parts of the apartments so that they can be thoroughly cleansed; and also to provide a safe, convenient privy or water-closet for the exclusive use of every one hundred such passengers. The master shall also, when the weather is such that the passengers cannot be mustered on deck with their bedding, and at such other times as he may deem necessary, cause the deck occupied by such passengers to be cleansed with chloride of lime or some other equally efficient disinfecting agent. And for each neglect or violation of any of the provisions of this section the master and owner of any such vessel shall be severally liable to the United States in a penalty of fifty dollars, to be recovered in any circuit or district court within the jurisdiction of which such vessel may arrive or from which she is about to depart, or at any place where the owner or master may be found.

8. Every vessel before taking on cargo or passengers shall be clean and dry, and the certifying officer may, at his discretion, require that it shall be thoroughly disinfected if last from an *infected* port, or if the port of departure be itself *infected*. The examination of the vessel as to cleanliness shall be made before the cargo is taken on, and shall extend to all accessible parts, especial care being taken to note upon the bill of health the presence of decayed wood.

9. Earth and porous stone shall not be used for ballast if avoidable.

10. Merchandise or articles known to be infected shall not be received or taken on board.

11. In case the port is *infected*, the certifying authority may require that the officers, crew, and passengers shall be examined by a medical officer or physician selected for that purpose, and the result of such examination reported to him not more than twenty-four hours before certifying to the bill of health.

12. Bills of health can be considered valid only when delivered within the twenty-four hours last preceding departure. If the departure is delayed beyond this period the bill must be *viséd* by the authority delivering it, stating whatever changes have taken place in the sanitary condition of the port, vessel, officers, crew, or passengers.

13. When the port of departure or its vicinity is *infected*, that fact shall be noted in the bill of health, and when the sanitary or other local authority of the port declares the existence of such infection, the bill of health shall give the date of the declaration.

14. The existence of contagious or infectious disease in the quarantine establishment of a port shall not be considered cause for a foul bill of health.

15. Physicians attached to sea-going vessels shall be specially charged with the duty of watching their sanitary condition and the health of their officers, crew, and passengers. On arrival of the vessel they shall report to the health officer of the port the sanitary history of the voyage.

16. In case of the occurrence at sea of Asiatic cholera, yellow fever, plague, small-pox, relapsing fever, or typhus fever, the wearing apparel and bedding used by those affected with such disease shall be boiled for not less than two hours or burnt or sunk.

17. Captains, owners, or agents of vessels shall, at the port of departure, be required to answer, under oath, to the consuls or sanitary officers all questions as to the sanitary condition of the vessel, &c.

18. Whenever any vessel shall leave an *infected* foreign port, or having on board goods or passengers coming from any place or district infected with Asiatic cholera, yellow fever, or plague, shall leave any foreign port, bound for any port in the United States, the consul, consular officer, or other representative of the United States, at or near such port, may, at his discretion, immediately give information thereof by telegraph to the National Board of Health at Washington, D. C., reporting the name, date of departure, and port of destination of such vessel. The cost of such telegrams will be paid by the National Board of Health.

19. All merchant ships or vessels from any foreign port where any contagious or infectious disease exists, and bound for any port of the United States, must present to the health officer at the quarantine station of such port evidence that these rules and regulations have been complied with in order that such vessel may enter such port, discharge its cargo, and land its passengers.

[Form A.]

No. ——. Port of ——.

THE UNITED STATES OF AMERICA.—NATIONAL BOARD OF HEALTH.

Bill of health.

I, —— —— (consul, consular agent, or other officer empowered by law to sign), at the port of ——, do hereby state that the vessel hereinafter named clears from this port under the following circumstances:

Name of vessel: ——.
Tonnage: ——.
Apartments for passengers, No. ——.
Destination: —— ——.

RULES AND REGULATIONS

Recommended to be adopted and observed when yellow fever is reported or suspected to exist in any town or place in the United States.

GENERAL EXPLANATIONS.

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B. Upon an outbreak of yellow fever, a competent medical officer should be assigned to the locality as health officer, to enforce the following rules and regulations:

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ANNUAL MEETING OF THE NATIONAL BOARD OF HEALTH.

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3. *On State, municipal, and local sanitary legislation.*—H. I. Bowditch, S. F. Phillips, S. Smith.

3. *On quarantine legislation—State, national, and international.*—S. Smith, S. F. Phillips, J. L. Cabell, S. M. Bemiss, P. H. Bailhache.

At the same meeting the Board revised the rules and regulations for securing the best sanitary condition of vessels, including their cargoes, passengers, and crews, coming to the United States from any foreign port where any contagious or infectious disease exists. The rules then, slightly modified, were submitted to the President of the United States, and were approved by His Excellency June 17, and are as follows:

RULES AND REGULATIONS FOR SECURING THE BEST SANITARY CONDITION OF VESSELS, INCLUDING THEIR CARGOES, PASSENGERS, AND CREWS, COMING TO THE UNITED STATES FROM ANY FOREIGN PORT WHERE ANY CONTAGIOUS OR INFECTIOUS DISEASE EXISTS.

[Prepared by the National Board of Health, in accordance with the provisions of an act approved June 2, 1879, entitled "An act to prevent the introduction of infectious or contagious diseases into the United States."]

EXPLANATIONS.

1. The object of the following rules and regulations is to prevent the introduction into the United States of "contagious or infectious diseases."

2. The following diseases are recognized as "contagious or infectious diseases" for the purposes of these rules and regulations, viz: Asiatic cholera, yellow fever, plague, small-pox, typhus fever, and relapsing fever.

3. An "infected" port or place, in the sense of these rules, is a port or place at which either Asiatic cholera, yellow fever, or plague exists, or at which either small-pox, relapsing fever, or typhus fever exists as an epidemic.

4. To secure the "best sanitary condition" of a vessel the ollow

Extract from report for quarter ending September 30, 1880.

NOMENCLATURE OF DISEASES.

At the conference held in Washington on the 6th and 7th of May, in accordance with a request of the National Board of Health as explained in the last quarterly report, the following resolutions offered by a member of this Board were unanimously adopted:

"*Resolved*, That the nomenclature published by the Royal College of Physicians of London be provisionally adopted.

"*Resolved*, That a committee of five be appointed by the chair, whose duty it shall be to indicate the most urgently needed additions to said nomenclature at the present time, and that this committee shall be instructed to confer with the committee of the Royal College of Physicians in charge of the revision of said nomenclature with reference to obtaining a uniform system both for Great Britain and her colonies and for this country."

Recognizing the great importance of this subject in connection with its bearing on the means of securing an exact registration of the causes of death, this Board has appropriated the sum of $500, or so much thereof as may be necessary, to defray the expenses of a selected member of the committee appointed under the above-cited resolutions, who shall be required to proceed to London and confer with the committee of the Royal College of Physicians engaged in the revision of the standard nomenclature of diseases.

The report of the committee on the best methods of tabulating mortality statistics is now ready and will be promptly published in the Bulletin of the National Board. There is good reason to believe that the tables prepared and recommended by the committee will be promptly adopted by most if not all of the registrars of vital statistics in the United States.

QUARANTINE.

The act approved June 2, 1879, the scope of which is foreshadowed by its title, "To prevent the introduction of contagious and infectious diseases into the United States," and the various requirements of which are in precise conformity with the import of that title, having imposed upon the National Board of Health certain obligations looking to the protection of the public health in that direction, it became a matter of anxious inquiry with the Board how it could best and most efficiently perform the duties prescribed in the law. The decision of this question with reference to a general plan of operations for future seasons was, however, of necessity left in abeyance for a time, by reason of the fact that almost immediately after the promulgation of the law the Board found itself confronted by an alarming outbreak of yellow fever in Memphis and by the occurrence of a few threatening cases in New Orleans. Subsequently the disease appeared in various other localities, as detailed in the first annual report of this Board, which, with its appended documents, has heretofore been transmitted to Congress. The infection having been already introduced, to assist the authorities of the stricken communities in their efforts to stamp out the disease, as a necessary means of preventing its spread to other States, was recognized by the very highest legal authorities of the general government to be the obvious duty of the Board under the provisions of the law which defined its powers. Owing, it is confidently believed, to measures recommended by this Board and to the pecuniary aid extended to the authorities of the endangered communities to enable them to carry these recommendations into effect, the spread of the disease was actually restrained within very narrow limits.

This very desirable result having been accomplished, and the period of danger of further developments of infection being past by reason of the occurrence of early frosts, the inquiry again pressed itself upon the attention of the Board as to its duties with reference to the future prevention of the introduction of contagious and infectious diseases into the United States from foreign countries and from one State into another. In this connection the Board did not overlook the great importance of maintaining, in the localities most exposed to the danger of the importation of infectious diseases, such an habitual condition of local sanitation as would be likely to render the poison when introduced *ab extra*, if not wholly inoperative yet much less potent for evil. To this end an elaborate sanitary survey of the city of Memphis was made by order of this Board, and certain measures, especially with reference to sewerage and repaving of the streets, were recommended. These measures were promptly carried into effect by the authorities of that city, and we may well congratulate the citizens of that stricken and impoverished community upon the results of their manful determination to bear the expenses incident to the execution of the improvements recommended. Notwithstanding the unexampled mildness of the past winter, which excited the fears of many persons lest some of the germs of the disease which prevailed until late in the fall might retain their activity through the winter and cause a new outbreak this year, there has not been a shadow of suspicion of the occurrence of a single case of yellow fever during the year, and the general health of the city has been unusually good.

With a similar end in view the Board sent two of its sanitary inspectors over to the Têche country in Louisiana, which had suffered more or less seriously from the invasion of yellow fever during the previous season, in order to ascertain its actual sanitary condition and what had been done by the local authorities in the way of local sanitation as a measure of prevention against the recurrence of an outbreak. It is not unreasonable to ascribe the immunity which that country has enjoyed the past summer from serious invasions of disease, in part at least, to greater care in regard to sanitary improvements consequent upon the action of the Board.

But, whatever care be taken in regard to municipal cleanliness, it is beyond all reasonable question that infected vessels and their cargoes and infected articles transported by railroads may plant the germs of disease in even the most cleanly cities. Accordingly, the municipalities which resolutely determined to exclude the infection at whatever cost and inconvenience to their own citizens and to those who desired to hold commercial intercourse with them, are accustomed in times of great danger to maintain the policy of absolute non-intercourse, enforcing this policy when necessary by means of the so-called "shot-gun quarantine," the barbarous cruelty of which has been made familiar to the public by numerous well-authenticated incidents of the epidemic of 1878. The efficiency of this policy was, however, abundantly established by the immunity enjoyed by numerous towns in the Valley of the Mississippi which adopted it, while the infection prevailed everywhere around them. To remove all occasion for the use of such a measure, by securing an adequate protection of the public health with the least obstruction to trade and travel, was doubtless the motive which led to the passage of the act of June 2, which had for its end the prevention of the introduction of contagious and infectious diseases into the United States from foreign countries or from one State into another, and which accordingly made it the duty of the National Board of Health to co-operate with and assist State and municipal boards of health in their efforts to secure these ends by means of quarantine regulations. With reference to

MARITIME QUARANTINE

as a means of preventing the introduction of disease into the United States from foreign countries or from an infected port of one State into those of another State by sea, there were two conceivable ways in which this Board might attempt to render aid to the local authorities. One was to make a *pro-rata* distribution of the funds at its disposal and available for this purpose to all the ports of entry which might seem to need such aid. This was at once rejected for the reason that, in addition to other more or less potential considerations, such, for example, as its opposition to the general tenor and spirit of the law and to the rulings of the Treasury Department, the distributive share of each beneficiary would have been so small as to render the act practically nugatory, inasmuch as a complete quarantine establishment is somewhat expensive with the original construction and as respects the annual cost of maintenance, including as it does a hospital for the sick, a lazaretto for persons not sick to be kept under observation until their freedom from infection is clearly established, a warehouse for the temporary storage of the cargoes of infected vessels, wharves to facilitate landing, lighters for conveying disinfected cargoes to the wharves of the port of destination, the seagoing vessels being sent to sea and thus returned to the uses of commerce in the shortest practicable time, and, finally, accommodations for the quarantine officer. To have given aid to this extent to all the exposed ports which needed it on the South Atlantic and Gulf coasts would have required more than ten times the amount of funds under the control of the Board. The only alternative seemed to be to select a few points so located as that a completely equipped quarantine station at each of them might avail for the protection of the intermediate ports, if their respective authorities would require all infected vessels bound for such ports to proceed first to these fully-equipped stations in order to undergo appropriate treatment. In such a case the ports themselves would need only the services of an inspecting officer to board vessels and to remand to the nearest national quarantine station such as had improperly attempted to enter the port against the published directions distributed by pilots.

As the stations thus proposed to be established were for the benefit not of a single State but of several, it was considered to be necessary and every way desirable to work them through the agency of employés directly responsible to the Board. The authority to do this was believed to be conferred by the law of June 2, 1879, inasmuch as it would be in aid of State and municipal boards of health, and this aid was to be extended at their request and with their active co-operation. The Board did not, however, take a step in this direction until it was fortified by the opinions of the legal advisers, namely, Solicitor-General Phillips, representing on this Board the law department of the government; Judge Porter, First Comptroller of the Treasury, who, under the law, had to pass upon all its accounts; and of Senator Harris, chairman of the Committee on Epidemic Diseases, which had framed the act in question. In the opinion of the latter eminent jurist the Board would have been derelict of its duty if it had failed to inaugurate some such measure for the protection of the country from the introduction of infectious diseases from abroad.

In undertaking this work the Board had the advantage of the remarkably successful experience of the quarantine authorities of the State of New York in protecting not only the ports of that State but all those of New Jersey and Connecticut which are reached through the harbor of New York. In the earlier operations of that quarantine only the vessels bound for the city of New York were subjected to its regulations, and though they proved effectual to exclude the *direct* importation of infectious diseases, it was soon found that such

Name of medical officer (if any): ——— ———.
Total number of passengers: 1st cabin, ———; 2d cabin, ———; steerage, ———.
Nature (vessel-of-war, ship, schooner, &c.): ———.
Guns: ———.
Where last from: ———.
Name of captain: ———.
Total number of crew: ———.
Cargo: ———.
Sanitary history of the vessel:

....

....

1. Sanitary condition of vessel (before and after reception of cargo, with note of any decayed wood). Note disinfection of vessel:

....

....

2. Sanitary condition of cargo:

....

....

3. Sanitary condition of crew:

....

....

4. Sanitary condition of passengers:

....

....

5. Sanitary condition of clothing, food, water, air-space, and ventilation (to be in quantity as required by Rev. Stats.):

....

....

6. Sanitary condition of port and adjacent country—
a. Prevailing diseases (if any):

....

b. Number of cases of and deaths from yellow fever, Asiatic cholera, plague, small-pox, or typhus fever during the week preceding:

b. Number of cases of—	*b.* Number of deaths from—
Yellow fever, ———.	Yellow fever, ———.
Asiatic cholera, ———.	Asiatic cholera, ———.
Plague, ———.	Plague, ———.
Small-pox, ———.	Small-pox, ———.
Typhus fever, ———.	Typhus fever, ———.
Relapsing fever, ———.	Relapsing fever, ———.

7. Any circumstances affecting the public health existing in the port of departure to be here stated:

....

....

CLEAN.

I certify that I have personally inspected the said vessel, and that the above statements are correct; that good health is enjoyed in this port and the adjacent country, without any suspicion of yellow fever, Asiatic cholera, or plague; that neither small-pox nor typhus fever exists as an epidemic; that the sanitary condition of the vessel, cargo, crew, and passengers is good; that the rules and regulations prescribed by the National Board of Health have been complied with, and that the [name of vessel] leaves this port in *free pratique*, bound for ———, U. S. of A.

[Signature of medical officer.]

Or,

FOUL.

I certify that I have personally inspected the said vessel, and that the above statements are correct, and that she leaves this port bound for ———, U. S. of A., in *quarantine*.

[Signature of medical officer.]

I certify that the foregoing statements are made by ——— ———, M. D., who has personally inspected said vessel; that I am satisfied that the said statments are correct; and I do further certify that the said vessel leaves this port bound for ———, in the United States, in ——— *pratique* [or in quarantine].

In witness whereof, I have hereunto set my hand, and the seal of office, at the port of ——, this — day of ——, 18—, — o'clock.

[SEAL.] ——— ———,
[*Consul General, Consul, Commercial Agent, Sanitary Officer, et al.*]

The within rules and regulations are true copies made this 17th day of June, 1880.

J. L. CABELL,
President National Board of Health.

THOS. J. TURNER,
Secretary of National Board of Health.

The foregoing regulations are approved.

R. B. HAYES.

JUNE 17, 1880.

CIRCULAR NO. 7.

The following rules govern the action of the National Board of Health in co-operation with and aiding State and local boards to enforce the rules and regulations of such boards to prevent the introduction of contagious and infectious diseases into the United States, or into one State from another:

1. The regulations to be enforced are those of State and local boards, and must be such as are approved by the National Board. The National Board, in its circular published in its BULLETIN No. 48, May 29, 1880, has recommended certain regulations with regard to maritime quarantine for adoption by State and local boards; and in its BULLETIN No. 50, June 12, in 1880, pages 402–403, it has advised the adoption of certain regulations during the existence of yellow fever.

It should be observed that these recommendations embody general principles only, the end in view being to protect and promote the public health by measures which interfere with travel or traffic as little as possible; in other words, to render commerce *secure;* and (with rare exceptions) *not to put an end to or even suspend it.* In this connection it is proper to add that non-intercourse quarantines, especially by *local* authorities, are not approved by this Board.

2. Applications to the National Board of Health for aid should be made by or through the State board; or in case there is no State board, then by or through the governor of the State, and should be accompanied by a copy of the rules and regulations for enforcing which aid is desired.

3. An application for aid must give *details* of what is required, and the estimated cost for each item, and must be accompanied by an official certificate from the governor of the State or the mayor or other chief officer of the municipality, respectively, to the effect that there are no State or municipal funds available to carry out the particular sanitary measures to secure which the application is made.

4. The aid furnished by this Board to local authorities must, as a general rule, be applied to other objects than those of shelter and furniture, which should be furnished by such authorities. Where, however, it shall be otherwise ordered, the local authorities will be expected to account to this Board from time to time for the safe-keeping and proper use of the furniture, provisions, medicines, &c., so furnished.

5. Whenever this Board shall order the erection of temporary buildings, or provide any buildings for the purpose of quarantine, the necessary contracts therefor shall be subject to the approval of the Board or of its executive committee.

6. Care should be taken that the officers to be paid from funds furnished by the National Board are employed only in such number and for such time as there is actual need of their services. The National Board of Health reserves the right of judging from time to time, by means of reports received from its own agents, whether such need exists.

7. Funds are not furnished by the Treasury to State or local boards. They are placed in the hands of the disbursing clerk of the National Board of Health, by whom bills, properly certified and approved, will be paid by check on Washington or New York. All bills must be in accordance with the estimates as approved by the Secretary of the Treasury, must be made out in duplicate on forms furnished by the National Board, and be *certified*, as to their correctness, by some authorized officer of the State or local board, and must be approved by some member or inspector of the National Board, duly authorized.

All bills for services rendered, or for articles furnished local or State boards, must be sworn to by the person rendering the service or furnishing the articles.

The names of all persons whose services as inspectors, &c., are to be paid for out of its funds must be submitted to and approved by the National Board.

8. State and municipal boards of health which receive aid from this Board are requested to furnish weekly reports to this office of their operations, including copies of orders issued by them and of reports made to them by their quarantine and sanitary inspectors with reference to the occurrence of cases of yellow fever and to measures adopted for isolating such cases; such reports to be presented in a form suitable for publication in the BULLETIN.

It is expected that at the close of the season a full report will be made by boards of health to the National Board as to their operations in carrying out those rules and regulations in which the National Board has rendered aid and co-operation, and it is desired that copies of all orders issued from time to time to inspectors shall be promptly furnished to this Board.

It is to be remembered that a full account of its expenditures must be made by the National Board of Health to Congress, and such account must set forth these expenditures in detail, and exhibit their propriety and necessity.

It is therefore essential that State and municipal boards co-operate with the National Board in supplying material for such an account, and it is earnestly desired that they preserve and furnish due evidence of the propriety of each item of their expenditure for both persons employed and articles purchased with the funds in question.

was the deliberate opinion of several competent physicians, and especially of Dr. G. M. Sternberg, of the United States Army, who has had a large experience in yellow-fever epidemics, and has made a special study of the character of the disease both in the United States and in Havana, as a member of the yellow-fever commission appointed by this Board to proceed to the latter place in order to investigate the nature of the fever in a locality where it has become permanently endemic. When this opinion was made known, a communication was addressed to the State board of health of Louisiana by Dr. S. M. Bemiss, the local representative of the National Board in New Orleans, offering pecuniary aid to prevent the spreading of the disease. This offer was declined, on the ground that there was no yellow fever in or near the city; whereupon, at the request of the citizens of New Orleans, a further investigation was made by a commission consisting of Dr. J. P. Davidson, of the State board, Dr. Sternberg, U. S. A., and Dr. J. D. Bruns, of New Orleans. A majority of this commission came to the conclusion that the disease in question was not yellow fever, but a severe form of malarial fever, probably caused by miasma from rice fields in the vicinity. From this opinion Dr. Sternberg has expressed his dissent, reiterating the emphatic expression of his belief that the disease, which is mainly confined to young persons, is a mild form of yellow fever; and in this opinion Drs. Bemiss and Mitchell, members of this Board, who have had a large experience in connection with yellow-fever epidemics in New Orleans and Memphis, have officially expressed their concurrence. Their reports and other papers relating to this question have been published in the BULLETIN, No. 16. It should be added that shortly after the reception of these reports the existence of an undoubted case of yellow fever within the limits of the city was announced in an official telegraphic dispatch to this office, signed by Dr. Bemiss and by Dr. Loeber, acting president of the State board; and Dr. Bemiss, in an official communication dated October 6, states that other cases, probably as undoubted as this, have occurred in and near the city.

AID TO THE DISTRICT OF COLUMBIA.

Information having been received at this office from Havana, Cuba, of the sailing from that port on the 24th of August of an infected vessel, the Emma J. Lewis, bound for Washington, the same was promptly communicated to the health officer of the District, Dr. Smith Townshend, and on his application for aid to prevent the introduction of yellow fever into the District of Columbia, a requisition was made for the sum of $250 to enable him to employ a sanitary inspector with authority to stop at the District limits all suspected vessels.

It should be added that the vessel in question has not arrived within the jurisdiction of the District, nor is it known that she has appeared within the capes of Virginia.

NATIONAL BOARD OF HEALTH,
Washington, D. C., August 10 1880.

SIR: Your communication of July 30, relative to the action of Dr. C. A. Rice, concerning the shipment of coffee from the port of New Orleans to Mobile, and to ports and places within the State of Mississippi, was duly received. A reply thereto was deferred until a report could be received from Dr. Rice, to whom, on the receipt of your communication, a letter of inquiry was addressed. I now find that Dr. Rice had anticipated the receipt of that letter, and had on the 5th of this month addressed a communication to the acting governor of Louisiana, furnishing an explanation of his action in the premises. This Board has also received by yesterday's mail a copy of a letter addressed to you by Dr. Bemiss the 2d of August. These two communications by a member of this Board and by one of its agents are approved by the executive committee, and cover the ground so well as to supersede the necessity for any more elaborate explanation.

It appears so obvious that the orders of Dr. Rice, though expressed in perhaps unguarded language, could have no other significance than that which is explained in his communication to the acting governor, that I cannot withhold the expression of my great surprise that after the explanations heretofore given you of the principles which have invariably guided this Board in the management of the inspection service at New Orleans, and your avowed concurrence, you should now seek occasion to ascribe to it or its agents any disposition to assume powers which it has never exercised or claimed to possess, and for the attempted exercise of which it would have incurred a great responsibility.

In this connection I refer to my letter of June 15, and your reply thereto, dated June 25.

In the former, adverting to the fact that certain rules and regulations which had been submitted to the State board of health of Louisiana were not intended to be in aid of that board, but of the health authorities of places above New Orleans, I remarked:

"This Board claims no authority whatever to require the owners of boats to submit to such inspection, but in the interest of inter-State commerce it agrees to make these inspections and to furnish certificates in the case of steamboats, &c., *upon request of the owner, agent, or captain of such boats*, in the hope and belief that the certificates will prevent unnecessary interference above, and thus operate to the great advantage of New Orleans and the towns above. If the authorities of New Orleans choose to make it obligatory on the masters of boats clearing from that port to undergo these inspections, the National Board could have no objection, but it disclaims any authority to make such order itself. The rules in question being recommended for the protection of places above New Orleans will doubtless be enforced by the local authorities of such places. The special object for which they were submitted to the State board of Louisiana was to invite suggestions and criticisms before they were finally adopted by this Board itself, and I may remark that since they were thus submitted they have undergone some modifications. As adopted they will be printed in No. 50 of the BULLETIN, a copy of which will be sent to you as soon as it comes out."

I further said:

"The executive committee directs me to say that while it has approved the appointment by Dr. Bemiss of three medical inspectors of railroads *nominated* by you, it does not clearly see that it was necessary or desirable to inaugurate railroad inspections in the absence of yellow fever, and inasmuch as a recent act of Congress in largely reducing the appropriation asked for by this Board, and restricting the use of a large part of the appropriation that was granted to the contingency of an epidemic, it will probably not be possible to continue this service beyond the present month (June) unless in the mean time cases of yellow fever should have occurred, in which contingency a portion of the appropriation not now available will become subject to the uses of the Board in extending aid to local and State boards of health."

In your reply, dated June 25, you say:

"The board of health authorized the president to express the conviction that the inspection of railroads is equally important with the river inspection service, and that both *are essential* to give confidence to the surrounding States and towns. The river inspection would be comparatively valueless without the railroad inspection, of which fact the faithful and efficient corps of inspectors have given many proofs. Dr. Rice, of the National Board (inspector), is in full accord with the State board on this subject. Up to the present moment the parties interested in the railroads and steamboats have yielded cheerful acquiescence to all the rules and regulations of the inspection service."

I have now to say that in no instance has this Board violated the principles avowed in my letter to you, and that if any of the inspectors at New Orleans whose salaries are paid by this Board, and most of whom were nominated by yourself, have transcended their authority, such act on their part will be disavowed and proper instructions promptly given.

I may observe, however, that even before receiving Dr. Rice's version of the matter the executive committee of this Board were of the opinion that the facts cited in your letter of July 30 did not sustain the interpretation you seemed desirous to put upon them. The committee was well assured that Dr. Rice could not possibly have meant to assert an authority which he had no means of enforcing, and the assertion of which would have been in direct violation of his instructions.

With reference to the last sentence of your letter, in which you complain of the action of Dr. Rice on the ground that it was taken "without the advice or co-operation of the lawful authorities to whom are confided by legislative enactment the conduct of the sanitary and quarantine affairs of the State of Louisiana," I have again to repeat the statement in my letter of June 15, that the whole of this river and railroad inspection service is intended for the protection of other States than your own, and is in aid of their health authorities. Incidentally, indeed, it was designed and has proved to be of great advantage to the commerce of New Orleans, since on the bare suspicion of a single case of yellow fever existing there the health authorities of the Mississippi Valley, and of other places in the South having commercial relations with that city, have declared that they will maintain a strict quarantine against it unless the inter-State commerce be carried on in accordance with the rules of the inspection service. These authorities have it in their power to protect their towns by a very simple and effective machinery. This Board has induced them to forego the use of such machinery and to consent to an arrangement which has proved highly advantageous to the commercial interests of New Orleans, and yet it encounters at the hands of the health authorities of Louisiana constant opposition and detraction. It is needless to say that it will continue to discharge its duties in aid of the health authorities of other States and municipalities notwithstanding the present opposition of the State board of health of Louisiana.

I will add that, owing to a delay in completing the arrangements at Ship Island, which has been due to causes beyond the control of the National Board, the time for extending aid to the health authorities of New Orleans with regard to the prevention of the introduction of contagious and infectious diseases through that port into the United States from foreign countries has not yet arrived. A recent official report to this Board by a committee consisting of three of its members satisfies the executive committee that the sanitary interests of New Orleans, and the surrounding country, will be best subserved by requiring infected vessels, and all vessels from infected ports, to undergo quarantine inspection and treatment at the proposed station on Ship Island. In this way aid will be offered to the

diseases, having been carried up the Sound, gained admission into the city by land from ports and places in Connecticut. This led eventually to the subjecting to the regulations of the New York quarantine all vessels entering the harbor, whatever might be their ultimate destination. This, it is believed, has been done without special legislation, but with the ready and cheerful acquiescence of the authorities of New Jersey and Connecticut. In like manner the quarantine station in Boston Harbor may avail, and to some extent it is believed has availed, for the benefit of other ports on the New England coast. On the South Atlantic and Gulf coasts, where, owing to climatic peculiarities and proximity to the permanently infected ports of Cuba, quarantine treatment of vessels is specially necessary for the public safety, there are no wealthy municipalities able to protect themselves and their neighbors. Periodically they are inflicted with disastrous epidemics which entail commercial losses and untold misery not only on the population of the ports first infected from abroad, but over a wide extent of the surrounding country. In the opinion of this Board this gigantic evil may be averted to a very large extent by the establishment, at a comparatively moderate expense, of a few completely-equipped quarantine stations, which may give to the ports of the South Atlantic and Gulf coasts the same protection which the New York quarantine has secured for that State and for the ports of Connecticut and New Jersey. This Board ventures, at the hazard of incurring the charge of tedious repetition, to bring this subject again to the attention of the honorable Secretary of the Treasury for transmission to Congress, in view of the fact that the Committee on Appropriations, to whom it was presented during the last hours of the recent session of that body, were not fully informed of the force of the considerations which actuated this Board in taking measures for the establishment and maintenance of the quarantine stations in question.

In the quarterly report of this Board for the quarter ending June 30, after adverting to the importance of the establishment and maintenance of quarantine stations under the auspices and control of the Board at Hampton Roads, Sapelo Sound, and Ship Island, it was stated to be "a subject of regret that owing to recent legislation by Congress it has not been possible to carry out these views except in a very partial manner.

"The funds at the disposal of the Board have necessitated, in the case of Hampton Roads, a temporary abandonment of a national quarantine, substituting therefor aid to the local authorities by the loan of a barge, purchased and equipped as a floating hospital, at a cost not to exceed $6,000. This was found to be less expensive, and in all other respects much better than to repair and fit the hulk of the Savannah, lying at the navy-yard at Portsmouth, Va., which had been courteously granted for the use of the Board by the Secretary of the Navy. For a like reason a temporary arrangement has been made at the Sapelo Sound Station by the use of hospital tents on the southern end of Blackbeard Island, and by the purchase of a steam launch for boarding vessels. The erection of a hospital, lazaretto, warehouse, and wharf at Ship Island had already proceeded so far before any question as to the policy arose as to make it highly inexpedient to alter the original plans of the Board in respect of that very important station." It is earnestly hoped that Congress will make adequate provision for the maintenance of this station, for the substitution of an adequate equipment at Hampton Roads and Sapelo Sound, in lieu of the temporary make-shifts adopted this summer, and for the establishment in Galveston Bay, or elsewhere on the coast of Texas, of a station for the protection of its extended coast line between Galveston and the mouth of the Rio Grande.

The municipalities most immediately concerned recognize the great value of these national quarantines, and earnestly desire that the machinery which will secure them against the introduction of infection from abroad, and thus against the risk of becoming the means of transmitting infection to other parts of the United States, shall be perfected and perpetuated. There is a partial exception to this remark in the case of New Orleans, where, although all the leading representatives of its commercial interests are known to be extremely desirous that infected vessels shall be required to proceed to the national quarantine at Ship Island instead of coming up the river to the Mississippi quarantine, to the great jeopardy of the population of the surrounding country on both sides of the river, the wishes of the community have been thwarted by the action of the State board of health, which has hitherto repelled all offers of aid on the part of the National Board looking to the reception and treatment at Ship Island of infected vessels bound for the port of New Orleans. This action of the State board of health of Louisiana has caused great dissatisfaction and alarm on the part of the people of the Mississippi Valley, who believe that there can be no adequate guarantee of the protection of the public health throughout the valley as long as infected vessels are permitted to enter the Mississippi River. This belief and the consequent distrust of New Orleans entertained by the health authorities of the States bordering on the river and its tributaries, are expressed in firm but temperate language in numerous articles of the daily press and in official ordinances of State and municipal boards of health.

The immediate occasion for the course adopted by the authorities of Tennessee and Mississippi, as alluded to, was the arrival of the bark Excelsior at New Orleans after a detention of eleven days at the Mississippi quarantine, and the occurrence of a fatal case of yellow fever among the crew during the discharge of its cargo of coffee. As soon as it was clearly established that the case in question was one of yellow fever the vessel was ordered back to quarantine, where four other cases occurred on board said vessel, of which two were fatal.

While the State board of health of Louisiana has thus, in defiance of the demands of the health authorities of the neighboring States, whose interests are so vitally concerned, declined to accept the offer of the National Board to receive and disinfect vessels clearing for New Orleans from infected ports, the authorities of all the ports between that city and Cedar Keys have signified their purpose to direct all infected vessels to report to the national quarantine at Ship Island before proceeding to their ports of destination.

In like manner the health authorities of the ports of the South Atlantic coast have solicited the establishment of a national quarantine in Sapelo Sound, and have instructed pilots to make inquiry, in all cases, before boarding, as to the sanitary condition of the vessels destined for these ports, and to order "all vessels having sickness on board, or on which serious cases have occurred during the voyage, to proceed at once to the national quarantine at Sapelo."

The period of danger with reference to the introduction of yellow fever into the United States being, for the present season, well-nigh past, measures have been taken to discontinue operations at Sapelo Sound, and to reduce the force at Ship Island by relieving the present quarantine officer, Dr. Martin, who will be placed on the reserve list, and by directing Dr. Collins, late supervising sanitary inspector at New Orleans, to take charge of the public property on the island and to perform the duty of boarding and inspecting all vessels which may require it during his stay at that station. These measures have been taken in conformity with the suggestions and advice of Dr. Bemiss, a member of this Board, who has had the general supervision of its work in New Orleans and the surrounding country, and especially of the operations at the Ship Island quarantine. It should be borne in mind that yellow fever prevails in Havana during every month of the year, and that in mild winters the ports of the Gulf coast would probably not be exempt from the risk of a general infection if infected vessels were permitted to come to their wharves.

As connected with this arrangement for the winter, it may be stated that the aid heretofore extended to the health authorities of the towns on the Gulf coast, between New Orleans and Pascagoula, has been suspended by placing on the reserve list the several sanitary inspectors at the ports of Hancock and Harrison counties, on the Mississippi Sound.

INTERSTATE QUARANTINE.

In conformity with the views and purposes expressed in former reports of this Board, especially in the last quarterly report, the systematic inspection by paid agents of the Board at New Orleans, Vicksburg, Memphis, and Cairo, of vessels bound for various points on the Mississippi above New Orleans, and at Bayou Sara of vessels proceeding up the Red River, has been in successful operation during the summer under the constant supervision and direction of Dr. R. W. Mitchell, of Memphis, a member of this Board, and has been productive of the best results in giving confidence to other communities otherwise disposed to establish a rigid quarantine against the city of New Orleans on the bare suspicion of the existence of a single case of yellow fever in that city.

Exception was taken by the State board of health of Louisiana to an order alleged to have been given by an agent of the National Board, prohibiting the shipment to Mobile and to ports and places in the State of Mississippi of coffee from the infected bark Excelsior, on which, as just recited, several cases of yellow fever had originated shortly after the handling of its cargo at the city wharves. In point of fact the order in question emanated from the health authorities of Mobile and Mississippi, and was promulgated by their authority by Dr. Rice, an agent of the National Board, with the simple view of warning shippers that the article, if shipped, would be declared contraband of quarantine, and would not be permitted to enter the ports referred to. The State board of health of Louisiana had previously been informed by the subjoined official communication from the president of this Board that the latter disclaimed any authority to interfere with the shipment of goods, or even to make inspections of steamboat freights, except at the request of the owners or captains of the boats, and the State board had, through its president, united in an earnest application to the National Board to make these inspections, not only of river craft, but also of railroads leading out of the city, on the ground that both were essential to give confidence to other communities. It is, indeed, true that the value to New Orleans of these inspections, in securing it from needless restrictions on its commerce, which otherwise would have been imposed by neighboring States, can scarcely be exaggerated.

An order to suspend these inspections by the 15th September for railroads, and by the end of the month for river craft, had been issued, when an earnest request was made by the authorities of Vicksburg, Miss., to reconsider the order so far as the river inspection service at that station was concerned. In compliance with this request the period was extended to the 15th October. The request was based upon an apprehension that an alarming outbreak of serious disease near Point à la Hache, in the vicinity of the Mississippi quarantine, might prove to be an epidemic of yellow fever, which had originated in the cases occurring on the infected bark Excelsior. Such, indeed,

Collins, Inspector S. H.; relieved from special duty in Memphis and ordered to Memphis station as inspector-in-charge May 21; transferred to New Orleans August 2; made supervising inspector at that port August 7, *vice* Rice, relieved; transferred to Ship Island quarantine station October 16.

Kennedy, Dr. S. D.; appointed inspector at New Orleans August 1; transferred to reserve corps September 30.

McCutchon, Inspector P. B.; transferred from reserve corps and assigned to duty at New Orleans May 25; transferred to reserve corps October 16.

Parham, Inspector F. W.; transferred from reserve corps and assigned to duty at New Orleans May 25; ordered to Memphis station to relieve Inspector Collins July 31; transferred to reserve corps October 1.

Rice, Inspector C. A.; transferred from reserve corps and assigned to duty as supervising inspector at the port of New Orleans June 2; relieved at his own request and ordered to Cairo station to relieve Inspector Smith August 7; ordered to Vicksburg station to relieve Inspector Banks August 21; transferred to reserve corps October 31.

Smith, Dr. W. R.; appointed inspector-in-charge of Cairo station July 14; resigned August 11.

The remaining *personnel* of the service comprised the officers and crew of the patrol boat H. H. Benner, a captain, pilot, mate, engineer, purser, carpenter, cook, watchman, two firemen, and three deck-hands; also two engineers and two firemen for the steam launches Lookout and Sentinel;* one boatman at the Cairo station; two boatmen and a cook at each of the stations at Memphis and Vicksburg, and one boatman and a watchman at the Bayou Sara station, making a total of eight inspectors and twenty-six employés.

While the director cordially acknowledges the intelligent and faithful support he has received from the inspectors generally, there is much to be desired in the methods of securing the proper officers for this service. During the prevalence of an epidemic it is usually easy to obtain the best professional services; but when the ordinary current of life goes on uninterruptedly it requires special inducements to cause medical men to abandon practice and isolate themselves from family, home, and society in the monotonous and irksome conduct of an inspection station. It will probably always be feasible to fill positions at large cities like New Orleans; but it can hardly be expected that the Board will meet with the same good fortune in the future that it has during the past season in satisfactorily officering the intermediate stations. These are, of necessity, unattractive positions, remote from companionship, and not seldom unhealthy, by reason of malarious surroundings.† When to this is added the limited duration of the season and rate of pay allowed, it will be seen that the service offers few inducements to properly qualified men.

THE NATURE OF THE INSPECTIONS, AND THEIR EFFECT UPON THE COMMERCE OF THE MISSISSIPPI VALLEY.

In anticipation of closing the stations on the 30th of September, a circular letter was addressed to the inspectors-in-charge on the 18th of that month, instructing them to forward with their detailed reports of the operations at their respective stations, concise statements of their views concerning the service, "(*A*) *From the standpoint of preventive medicine*, as tending to secure (1) a better sanitary condition of vessels; (2) a heightened sense of public-health responsibility among shippers and common carriers; (3) more efficient safeguards against the spread of epidemic diseases; and, (*B*) *from an economic standpoint*, as tending to prevent unnecessary interruption to travel and traffic during the existence of such diseases." In answer to this request the following, from Inspector Parham, was received among others, and is here furnished as embodying the result of the practical experience of one of the most intelligent and impartial of those engaged in the service:

REPORT UPON THE OPERATIONS OF INSPECTION STATION NO. 2.

[By F. W. PARHAM, M. D., Inspector-in-charge.]

I have been requested from the office of the director to make a statement of my views concerning the inspection service now closed. I will, perhaps, make myself clearer by prefacing my remarks by a brief description of the manner in which inspections have been performed at New Orleans and at this station. Having been assigned to duty at New Orleans for the months of June and July, and at President's Island (below Memphis) during August and September, I can speak from personal observation at both places.

In New Orleans boats were requested to notify us, as soon after arrival as possible, when it would be convenient for the inspector to make the necessary examination. This time was generally after the cargo had been discharged and the rubbish removed from the hold and deck. The boat was examined throughout from keelson to "texas." If her condition was found in all parts satisfactory, she was permitted to take on cargo, but if the bilge, hold, or other part *inaccessible* in a *loaded* boat was discovered in insanitary condition, directions were given for removing objectionable features, and a second visit was paid to ascertain what effort had been made to carry out instructions before loading began. Finally, just before departure an examination was instituted especially to determine the character and condition of cargo,* to visit those portions of the boat not seen in the previous inspections, to see all sick persons on board, and to furnish the certificate filled out according to the facts.

At this station, President's Island, the manner of proceeding was somewhat different. Boats from Vicksburg and above were treated as in New Orleans, excepting that only one inspection was required, all desired information being attainable, owing to the fact that during the summer season these boats do not carry much freight in the holds. With reference to boats from New Orleans, if the New Orleans inspector had certified that the condition of the boat, her cargo, and passengers, was entirely satisfactory, or, if this not being the case, the inspector at station No. 1 had indorsed on the certificate, as the result of his examination, that all objections of the New Orleans inspector had been removed, it was not considered necessary at this station (No. 2) to detain the boat so long as would be required to enable the inspector to make a thorough reinspection; but any changes in cargo and passengers since leaving last station were noted, all sick persons on board were personally examined, and the diagnoses stated in the form.

If a boat had not an originally "clean" bill nor a proper indorsement by last inspector, she was examined with reference to those points objected to by the last officer of the service, or, no matter what the certificate evidenced, if the boat was one whose officers had in any way betrayed a desire to cover up insanitary conditions, such search was made as was necessary to determine the actual facts, and the result was stated on her bill without alluding to the conduct of the officers. Thus the service has been carried on. The foundation principle, that the power of the inspectors was derived solely from the will of the people, as expressed through their State or local health authorities in demanding that boats should comply with the regulations of the National Board of Health, has been fully recognized, and nothing unreasonable has been asked, and the smallest possible inconvenience and detention of boats have been entailed.

SANITARY AND ECONOMIC RESULTS OF THE SERVICE.

I am of opinion, from experience and reflection, that some practical good has been accomplished by the operations of the service this summer. I will discuss the question from the two points of view suggested in the letter of the director of the service, namely, *A, preventive medicine; B, economy.*

As a measure of preventive medicine this service has secured, first, an improved sanitary condition of steamboats and barges. The parts of a boat most likely to accumulate dirt and filth and those to which naturally the least attention is generally paid are the bilge, the water-closets (particularly those on lower deck used by roustabouts), and the crew's quarters. The hold is generally cleaned out after unloading, but the bilge, with the exception of occasional pumpings, is only at long intervals thoroughly purified; the water-closets for passengers are usually tolerably well cared for, but those used by the deck-hands, being more indecently and frequently patronized, are very often found in very filthy state; the quarters for crews, especially those on main deck, are, in many instances, badly ventilated and kept closed for the most part of the day, furnished badly and unused to cleanliness, or, indeed, to decency.

The practical benefits secured by the inspections are:

1. The attention of captains has been *repeatedly* called to these insanitary conditions and to the necessity of correcting them. 2. They have been told *how* this could be done, and 3. They have generally *attempted* some improvement, and in many cases succeeded in satisfying the demands of the service. Second inspections have often revealed the turning up of the dunnage-boards, for the removal of decomposing grain and other organic matter and mud, and the improvement of the odor of bilge-water by the (total or) partial substitution of fresh, with the addition of copperas; the cleansing of the water-closets and their disinfection with copperas-solution, lime-wash or chloride of lime; the better ventilation of sleeping apartments and greater attention to neatness. Sometimes boats remained in port so short a time that little could be accomplished before departure, and it was not deemed prudent to invite opposition by harshness or the attempt to enforce the execution of the measures advised. Under these circumstances the facts were stated on certificate, and the captain requested to have the directions carried out as far as possible *on the way up* the river. This course had to be pursued with some steamboats and with many barges, and was found to work very well. At this station, I have examined barges, certified to by inspectors below as in bad sanitary condition, in an advanced state of purification and

* The sanitary patrol boat and the two launches above named were delivered to the director at Memphis July 7, and the remaining launch, the Picket, was received at Cairo July 13.

† At the Vicksburg station, three and a half miles below the city, every person on duty during the season suffered from malarial fever; one inspector was permanently invalided and obliged to resign, and at one time, for a period of nearly three weeks, there was not a single well person at the station. This was attributed in part to the insufficient protection afforded by the tents in which the people were housed at this station.

* It should be stated that especial attention was paid to the following articles of cargo: coffee, sugar, fruits, and other articles from tropical ports, second-hand bedding and clothing, rags and paper-stock. The sanitary history of all shipments of the last four articles—namely, second-hand bedding and clothing, rags and paper-stock—was carefully inquired into, and the information elicited was entered upon the certificate of inspection for the benefit of intermediate ports as well as the port of destination. The publicity thus given led to the almost total abandonment of shipments of this dangerous character during the summer months.
M.

State board of health of Louisiana for the protection of New Orleans and all places in direct communication with it.

I will further add, as suggested by the general tenor of your communication, that while the acts of Congress require the National Board of Health to co-operate with and, so far as it lawfully may, aid State and municipal boards of health, it was obviously for the purpose of ascertaining and deciding when and in what manner such aid should be given that a National Board was created. Had this not been so, and had Congress intended to allow each State and each municipality to decide these questions for itself, it would, doubtless, have dispensed with any intermediate instrumentality, and have authorized each local authority to make its requisition directly on the Treasury Department for funds needed to carry out its objects.

Respectfully,

J. L. CABELL,
President National Board of Health.

Dr. JOSEPH JONES,
President of State Board of Health of Louisiana,
New Orleans, La.

THE FEVER ON THE LOWER MISSISSIPPI.

NEW ORLEANS, *October* 4, 1880.

SIR: Definite information of the existence of a suspicious form of fever in Plaquemines Parish, La., on the Lower Mississippi, having been received by the member of the National Board of Health resident in New Orleans, George M. Sternberg, surgeon, U. S. A., was requested to visit the locality, examine such number of cases as might be necessary to enable him to determine the nature of the fever, and report the result of his investigation to the New Orleans member. Surgeon Sternberg was selected for this duty because of his extensive and intimate acquaintance with the fevers of the Gulf coast and Spanish Main; because of the recognized skill and ability which had led to his being chosen one of the experts on the Havana Yellow-Fever Commission, and to his being intrusted with the duty of preparing the article on yellow fever in the supplement to Ziemssen's Cyclopedia, and also because of his position as a United States Army medical officer, which, while it removed him on the one hand from the probability of having his judgment or conclusions influenced by local or personal considerations, on the other, devolved upon him the responsibility of representing an extremely sensitive professional body.

On the 10th of September Dr. Sternberg made a detailed report, in which, after reciting the history of the sickness from the appearance of the first case, early in August, up to the date of his investigation, he positively asserted the existence of yellow fever of a mild type, with a low rate of mortality, except where the disease was aggravated by vicious local conditions. In the area where this prevailed, Dr. Sternberg also found a malarial fever, attributed by the local physicians to exposure in the rice harvest, and which they called rice fever.

Upon receipt of this report a telegram was sent to the executive committee asking that, if Dr. Sternberg's opinion was of sufficient weight, an appropriation of from five thousand to ten thousand dollars be made from the contingent fund and placed at the disposal of the Louisiana State board of health for use in the necessary preventive measures. The appropriation was immediately ordered, and a tender of the sum was made, as above indicated, on the 13th of September.

Recognizing only the existence of the so-called rice fever, the State board declined the offer of the National Board and claimed to have "instituted such measures as it deemed necessary." Up to this time the action of the Louisiana member representing the National Board of Health had been governed by that portion of sec. 3 of the act of June 2, 1879, which makes it the duty of the Board to "co-operate with and, so far as it lawfully may, aid State and municipal boards of health in the execution and enforcement of the rules and regulations of such boards to prevent the introduction of contagious or infectious diseases into the United States from foreign countries, and into one State from another."

The rejection of this proffer to "co-operate and aid," however, now made it incumbent upon the National Board, through its representative, to take such steps as might determine whether the contingency was grave enough to warrant action under that clause in section 3 which directs the Board to "report the facts to the President of the United States," whose duty it then is to use the Executive authority in executing and enforcing the necessary rules and regulations. With this object the member of the National Board of Health resident in Memphis was summoned to New Orleans, and, after a careful consideration of all the facts, it was decided to send a commission of three medical gentlemen to the compromised locality, and to base the action of the Board upon the report of said commission. These gentlemen (selected with the approval of the auxiliary sanitary association) were Dr. J. Dickson Bruns, of New Orleans, Dr. J. P. Davidson, of the Louisiana State board of health, and Surgeon Sternberg, U. S. A., and they were accompanied on their mission by the Tennessee member of the National Board, the Louisiana member being prevented by his only partial convalescence from a recent attack of the prevailing dengue.

Without entering upon any discussion of the two reports made, the one by Drs. Bruns and Davidson, and the other by Surgeon Sternberg, it is sufficient for the present purpose to say that it was made evident, as well by the conflicting reports of the commission as by the personal observation of the Tennessee member, that no practical benefit could now be obtained from Executive interference.

Whatever danger had threatened the public health of the Mississippi Valley had either passed away—the disease having run its course—or it had been so widely scattered that preventive measures on any adequate scale were impracticable for the time being.

Considering the advanced stage of the season, the favorable health conditions of the valley, the more than doubtful utility of any steps still possible looking to isolation, disinfection, &c., and the desirability of avoiding overt action likely to create anxiety and apprehension, if not positive panic—these considerations have induced the representatives of the Board to refrain from recommending further action in the premises at the present time.

They cannot, however, close this report without placing themselves on record as fully accepting and indorsing Surgeon Sternberg's conclusions, to wit:

1. That yellow fever (about 100 cases) existed between August 1 and September 10 in Plaquemines Parish, Louisiana.

2. That the outbreak had its origin in the immediate vicinity of the Mississippi River quarantine station, the first case, August 1, occurring directly opposite the point where the infected bark Excelsior was detained from July 11 to August 16.

3. That while the type of the disease was generally mild, vicious local conditions existed which aggravated it into the most fatal form, four dying in one family out of five attacked.

The details of the investigations upon which these conclusions are based will be found in the accompanying reports of Surgeon Sternberg.

All of which is respectfully submitted.

S. M. BEMISS,
Member National Board of Health, New Orleans, La.
R. W. MITCHELL,
Member National Board of Health, Memphis, Tenn.

To the SECRETARY OF THE NATIONAL BOARD OF HEALTH,
Washington, D. C.

APPENDIX T.

MISSISSIPPI RIVER INSPECTION SERVICE.

Report of Dr. R. W. Mitchell.

MEMPHIS, TENN., *December* 31, 1880.

SIR: Pursuant to instructions dated May 15, 1880, I was placed in charge of the Mississippi River inspection service, and directed to locate and put in operation the several stations forthwith, and to organize the service in all its details in accordance with the plans and estimates previously submitted and approved by the executive committee. Dr. F. W. Reilly was ordered to report for duty as my assistant, and I empowered him to select inspectors for the various stations, officers, engineers, and other employés for the patrol boat and launches (then being built at Pittsburgh, Pa.,) and all other persons necessary for the conduct of the service, subject to the approval of the executive committee of the National Board.

On the 25th of May, inspections were begun at the port of New Orleans, the stations below Vicksburg, Miss., and Memphis having been meanwhile established, with inspectors Banks and Collins in charge respectively. June 23, an additional station, in charge of inspector Ashton, was established at Bayou Sara, La., at the request of the Shreveport, La., board of health, and of the steamboat interests concerned in the navigation of the Red, Ouachita, and Atchafalaya Rivers. The establishment of the Cairo, Ills., station was deferred (pending the receipt of the necessary request from the local health authorities), until July 14, when it also was opened, in charge of inspector Smith.

Inspections were continued at New Orleans and Vicksburg until October 15—an extension beyond the time originally contemplated (September 30), made necessary by the action of the Vicksburg authorities, who, in view of the sickness in Plaquemines Parish, La., below New Orleans, and for other reasons, made, on September 24, a formal request that inspections of boats, clearing from New Orleans for Vicksburg, be continued until October 15.

The station at Cairo was suspended, provisionally, on August 21, primarily because of the absence of suspicious sickness in the valley above New Orleans, and incidentally because the expense of maintaining the additional station at Bayou Sara had not been estimated for, and its maintenance—which was deemed important—had trenched upon the sum at the disposal of the inspection service.

PERSONNEL OF THE SERVICE.

The following-named persons were employed as river inspectors during the season:

Ashton, Dr. W. W.; appointed inspector-in-charge, Bayou Sara station, June 12; transferred to reserve corps October 7.

Banks, Dr. E.; appointed inspector-in-charge, Vicksburg station, May 24; resigned August 23.

the progress of the work could in some instances be traced. It is true we have met with objections and refusals to comply with our regulations, but in the main an unexpected acquiescence has been experienced and the sanitary condition of boats and barges has been improved. It may prove of interest to glance at the agencies that have brought about this desirable result:

(1.) Letters were early in the season addressed to the presiding officers of steamboat and transportation companies in Saint Louis, Cincinnati, and elsewhere, requesting them to issue such orders as would facilitate the work of the inspectors. In response to this request, written orders were sent to the different boats of the Saint Louis and New Orleans Anchor Line, verbal instructions to the Saint Louis and New Orleans Transportation Company (barges) and to others. These orders materially assisted the efforts of the inspectors, as they were generally carried out.

(2.) Letters were sent the New Orleans agents of barge-lines requesting them to have their barges overhauled as thoroughly as possible, and cleaned out in Saint Louis, where the work could be better and more expeditiously accomplished. In complying with this request the managers aided us by starting out the barges for the summer trade in much better condition than heretofore.

(3.) The spirit of rivalry among boats in matters of cleanliness was stimulated by the watchfulness of the service.

(4.) The fear of detention or of exclusion from certain landings, when no certificate had been obtained, also operated to effect the end in view, and—

(5.) The experience of the past called attention to the possible renewal of the establishment of onerous and hurtful quarantines, and the results of 1879 seemed to promise an avoidance of these evils for 1880, at the same time that the public health was more perfectly protected. The steamboat interest deemed it wise to foster a service moderate in its demands, and approved by the people.

I can offer no evidence that the service has secured "a heightened sense of public health responsibility among shippers and common carriers," save (1) a manifest desire to understand what was required; (2) the readiness in many cases, compared with the unwillingness in others, with which they complied with all the rules and regulations; and (3) the opinions pronounced by some interested in the *protection* of trade as to the necessity of imposing such *restraints* upon commerce as the preservation of the public health demanded—taken in connection with (4) the high and *impartial* stand in the outset assumed by the National Board of Health, offering a hope that a middle course might be steered with safety between the protection of health and the destruction of business—*enlightened* the people, and called a halt to the selfish tendencies of the business community.

"(c.) More efficient safeguards against the spread of epidemic disease along the valley."

The *frequent* repetition of inspections diminished the chances of transportation of infected persons or things by affording increased opportunities to detect what might have eluded the vigilance of preceding inspectors as to existence of articles of freight of doubtful nature, and to discover the development in transitu of contagious and infectious disease.

The number of stations and the accessories there found provide for the better care and treatment of the sick, which shot-gun quarantines recklessly ignore. The service provides for the employment of an extra physician and nurses to attain these desirable ends. It also secures the more complete isolation of the *sick* from the *well* of the boats and from communities. Medical attendants and nurses are debarred communication with the station and the outside world (except under necessary restrictions), and are enjoined not only to keep vigilant watch over the condition of the sick, but also to restrain their movements within certain limits. The arrangements at station No. 2 permit the accomplishment of this by means of a hospital-float, moored at a convenient but safe distance from the inspection station, and of hospital-tents. Comfort and isolation can thus be obtained.

The housing and care of the healthy or uncompromised among the passengers, who are detained for observation and isolated until such time as it is deemed safe for them to proceed, are also amply provided for, as is likewise the efficient treatment of infected vessels.

This station, situated near the southwestern extremity of President's Island, offers peculiar advantages for the objects above enumerated. Distinct from the mainland, distant 10 miles from Memphis, and sparsely populated, furnished with all necessary appliances and conveniences, it is possible to accomplish the most satisfactory attainable isolation.

Considered from an "economic standpoint," the service certainly commends itself to the good will of the steamboat interest and the public generally.

At least fifty authentic cases of yellow fever occurred in the city of New Orleans in the summer and early fall of 1879, and the prejudiced even must admit that there was an *unusual lack* of absurd and onerous quarantines, which so often entail suffering and pecuniary loss. I think I do not go too far in asserting that part at least of this desirable result had its source in the disinterested efforts of the National Board of Health.

Further, comparison of the amount of business transacted by river and rail in 1879 with that done in years preceding the inauguration of this service will demonstrate that the confidence of the people has been enlisted, and that hasty and ill-advised quarantines did not cause much interruption to business, though danger at one time (in 1879) undoubtedly threatened.

The history of the circumstances connected with the arrival in New Orleans, on July 6 (when all the conditions were favorable to the development of yellow fever), from Rio de Janeiro, of the infected ship Excelsior will prove the same proposition for 1880. The action of the National Board of Health, in promptly notifying constituted authorities, and the measures taken to prevent any spread of infection from New Orleans, together with the action of local boards of health in menaced communities in co-operation with this service, undoubtedly averted panic, established confidence, and obtained exemption from disease without seriously hurting business.

Finally, the service invites the approbation of the shipping interest from the fact that during 1880 the *only expenses* incurred by boats were for the purchases of disinfectants, for the work done by the boat in cleaning, and for consumption of fuel and loss of time, made necessary by detention at intermediate stations.

WORK PERFORMED.

During the season, as above—namely, from May 25 to October 15, inclusive—there were inspected 1,514 vessels, with an aggregate capacity of 1,234,450 tons, and carrying 81,395 persons, including passengers, officers, and crews. Special inspections of coffee shipments—2,612 by river, and 2,552 by rail—were also made at the port of New Orleans, where, also, 26 passenger and 525 freight trains were inspected; making a grand aggregate of 89,274 river and rail inspections by the service.

The following tables exhibit this work in detail:

	Inspection at—				
	New Orleans.	Bayou Sara.	Vicksburg.	Memphis.	Total.
Of vessels	387	297	365	465	1,514
Persons thereon	27,828	16,787	20,305	16,475	81,395
Railroad passenger trains	26				26
Persons thereon	650				650
Railroad freight train	525				525
Coffee shipments	5,164				5,164
Total	34,580	17,084	20,670	16,940	89,274

Aggregate number of persons inspected.

	Number.
Passengers, officers, and crew, by river	81,395
Passengers, only, by rail	650
Total	82,045

Aggregate freightage inspected.

	Tons.
Tonnage of vessels	1,234,449.87
Railroad freight	105,127
Total	1,339,576.87

Among the 82,045 persons inspected, only 118 cases of sickness were found, as follows:

Intermittent fever	84
Remittent fever	9
Chronic malarial toxæmia	5
Dengue	7
Acute dysentery	3
Chronic diarrhœa	6
Phthisis pulmonalis	1
Senile debility	1
Hives	2
Total	118

Of these the majority were found during the month of September, and mainly among the crews of tow-boats. Only 1 death (congestive malarial fever) occurred from disease during a voyage. Five cases of dengue were taken from the tow-boat *Raven* in the latter part of August, and treated in the floating hospitals at the Vicksburg station. (See detailed report.)

THE FLOATING HOSPITALS.

Two reasons induced the director, soon after the opening of the inspection season, to recommend the purchase of small flatboats out of which to extemporize floating hospital wards to be attached to the inspection stations. The first of these was the more perfect isolation which could be secured by the reception and treatment of cases of infectious or contagious disease on such floats; the second was that their use overcame the only opposition met with in the location of the stations. This opposition was of a most pronounced character at every place except on President's Island, near Memphis, and was based on the natural fear of those living near the proposed sites of

forces the conviction that travel would have been impeded and traffic more or less completely interrupted.

That the requirements were not made more stringent and did not impose greater restrictions upon commercial and personal intercourse between New Orleans and the State of Tennessee is due solely to the confidence reposed in the inspection service of the National Board of Health, both at New Orleans and throughout the valley. In the absence of this agency it would have been the imperative duty of the State board, and of local boards throughout the State, to recommend the absolute prohibition of all freight and a quarantine of observation for all compromised passengers from New Orleans, until a sufficient period had elapsed to determine whether the five cases and three deaths from yellow fever among the crew of the Excelsior and her 3,600 sacks of presumably infected coffee were to be the seeds of another epidemic—as the single case from the Valparaiso was the seed of the epidemic of 1873, with its harvest of 16,000 cases and 4,000 deaths in Shreveport, and Memphis, and Montgomery, Ala., and Calvert, Tex., and other places; or as the single case from the *Emily B. Souder* was the insignificant and uncared-for beginning of the widespread pestilence of 1878.

It is submitted to your excellency, and to the public, that the inconvenience and pecuniary losses caused by this admission of a vessel from an infected port into the port of New Orleans in midsummer bear no comparison to the cost (aside from the question of human life) which similar action has entailed in the past.

How far the State board of health of Louisiana is to be credited with the good fortune that an epidemic has not yet resulted from the Excelsior it is not our province to discuss. But it is entirely proper to assert, in the light of what has since occurred, that the orders of the State boards of health of Mississippi and Tennessee averted a panic, prevented the interruption of travel and traffic, and restored confidence throughout the valley of the Mississippi in many communities which have not yet forgotten the history of the year 1878.

Very respectfully,

G. B. THORNTON, M. D.,
JOHN JOHNSON,
Members Tennessee State Board of Health.

The following letters, among others, were received in reply to the foregoing, and the director is indebted to the courtesy of Dr. Thornton and the Hon. John Johnson for the copies here given:

From his excellency the governor of the State of Mississippi:

EXECUTIVE DEPARTMENT,
Jackson, Miss., August 18, 1880.

GENTLEMEN: I have the honor to acknowledge the receipt of your communication of the 14th instant, inclosing copies of your letter of same date to the governor of Louisiana, and official order of the State board of health of Tennessee, dated July 14, and soliciting my views on the general subjects involved therein, especially on the relations of New Orleans to the Mississippi Valley in the matter of excluding vessels from infected ports during the dangerous season, and upon the value of the inspection system as an agency for obtaining and imparting information to threatened communities, by which they may be enabled to take prompt and intelligent action for prevention with the least possible interruption to the movements of merchandise and persons.

Upon the general subject involved I do not hesitate to express the opinion that the State board of health of Tennessee, with the lights before it, and in view of the lamentable experience of 1878 and 1879, was fully justified in the issuance and publication of the order referred to. It had the effect of forestalling unnecessary local quarantines and preventing a recurrence of the excitement of 1878, without seriously affecting the commerce of the country. As New Orleans is the gateway through which yellow fever is introduced into the adjacent States and those bordering on the Mississippi River, it certainly devolves upon the authorities of that city to exclude vessels from infected ports during the dangerous season. If they should refuse, neglect, or fail to do this, or if fever should find its way into New Orleans notwithstanding all proper and reasonable efforts to exclude it, it then becomes the duty of those charged with the protection of the health of other States and communities to adopt such measures as may be necessary to prevent its introduction into such States and communities. The system of inspection is, I think, of great value, if faithfully carried out. Information thus obtained will generally be received with more confidence than that coming from the local authorities of suspected communities. By means of a thorough system of inspection all threatened localities may be protected without serious interruption to the movements of merchandise and persons destined to points exempt from the dangers of epidemic disease. The dignified and manly tone of your letter commends it to the respectful consideration of all concerned, and I see nothing in it to give offense to any. An earlier reply to your favor was prevented by my absence, and I have taken the first opportunity since my return to write.

Very respectfully, your obedient servant,

J. M. STONE.

From his excellency the governor of the State of Tennessee:

EXECUTIVE OFFICE, NASHVILLE, TENN.,
August 16, 1880.

GENTLEMEN: At your request, I have examined the "official notice from the State board of health," and your joint letter to the governor of Louisiana, and it seems to me the measures adopted for the protection of our people are wise and prudent, and that your letter, while respectful and cordial, is conclusive.

Respectfully and truly,

ALBERT S. MARKS.

From the president of the State board of health of Arkansas:

STATE BOARD OF HEALTH, LITTLE ROCK, ARK.,
August 26, 1880.

GENTLEMEN: In reply to yours of the 14th, allow me to say that I fully indorse the action of your Board in issuing the order of July 14, 1880, for the same reasons so fully set forth in your published "open letter" to the governor of Louisiana. The Arkansas board of health relied on the wise and efficient precautions of the National Board of Health for protection against the spread of yellow fever in the matter of the Excelsior, and have no reason to regret this confidence. I am still of the opinion that the national government, with the co-operation of the States, is as fully competent to protect its people from the importation and spread of infectious or contagious diseases as it is in keeping from our shores an armed enemy.

Very respectfully, your obedient servant,

A. L. BREYSACHER, M. D.,
President Arkansas State Board of Health.

From the State board of health of Mississippi:

HOLLY SPRINGS, MISS.,
August 17, 1880.

GENTLEMEN: In answer to your letter of 14th August, asking my opinion on matters therein contained, I would say that I deem the inspecting system instituted by the National Board of Health for the protection of the people of the Mississippi Valley a necessity, not only to prevent the introduction of yellow fever, but that the traveling public and the commerce of the country might not (in a great measure) be interrupted.

I think it would add greatly to the safety of the people of the Mississippi Valley that no vessels from a place infected with yellow fever should be permitted to enter the port of New Orleans during the heated term or dangerous season.

Yours,

F. D. DANCY,
Member of Mississippi State Board of Health.

From the secretary of the State board of health of Massachusetts:

STATE BOARD OF HEALTH, LUNACY AND CHARITY,
STATE HOUSE, BOSTON,
August 24, 1880.

GENTLEMEN: In reply to your favor of the 14th instant, it gives me pleasure to say that the action of the Tennessee State board of health has been, in my opinion, in all respects judicious in the matter of quarantine regulations referred to. It seems to me too clear to need the statement that the only protection against pestilence and ruin of commerce for the Mississippi Valley lies in thorough inspection under the control of such a body as will command universal respect and confidence.

I am, very sincerely, yours,

CHAS. F. FOLSOM.

From Dr. Stephen Smith, of New York City:

NEW YORK, *September* 1, 1880.

GENTLEMEN: I have read your "open letter to his excellency the chief executive of the State of Louisiana," with great interest, and submit the following criticism upon the subjects embraced in it. I do so with more confidence because I have recently visited many of the principal towns of the Mississippi Valley, and have freely discussed matters pertinent to your letter with members of State and local boards of health and with leading citizens. The feature of your communication which impresses me most forcibly is the statement that the interests of the communities of the Mississippi Valley are identical with those of New Orleans—"that whatever helps or hurts New Orleans helps or hurts Memphis and the rest of the valley." This great practical truth is fully recognized in regard to every branch of industry and of trade. The Mississippi Valley is acknowledged by competent authority to be capable of supporting the largest population and developing the greatest amount of material wealth of any equal territory in the world. New Orleans by location is, and doubtless will continue to be, the commercial metropolis of this region. It follows that the prosperity of this favored city must depend upon the growth of the population of the river States and the development of their immense natural resources. The interests of the people of the valley, and of its commercial center, are, therefore, identical. But what is the chief obstacle to-day to the progress of New Orleans, and of the Lower Mississippi, in population and industrial development? Everywhere in that region thoughtful citizens

reply, "Yellow fever." Said an intelligent physician of large experience: "The dread of this pestilence is so deep-rooted and universal that the present population is unsettled and immigration prevented." A large cotton planter of Louisiana remarked: "If we could give satisfactory guarantees that yellow fever would never visit the valley again we could raise annually 20,000,000 bales of cotton where now we raise our present crop. One great want is laborers." This fear of yellow fever may be irrational, but, nevertheless, it exists, and cannot be removed by argument, persuasion, or coercion. In the opinion of the most sagacious citizens, only measures which give the most satisfactory proof that they are capable of preventing a return of the epidemic will allay public apprehension. And, of all the measures proposed, none will satisfy the public demand but those which secure *positive non-intercourse of the well with infected materials and persons.*

Whatever theories medical men may hold as to the origin and mode of propagation of the disease, the people of the valley have determined upon one mode of protecting themselves against it, viz, *non-intercourse with the infectious material.* And civil and health authorities throughout the valley recognize the justice of this demand, in the absence of any more satisfactory measure, and direct all their efforts to accomplish this object. Naturally, they turn their attention, first, to the mouth of the Mississippi River, through which the commerce of infected ports chiefly enters the valley, and through which the infection has frequently come to towns far up the valley in its most virulent form, as the point where defensive and preventive measures can be most easily placed and effectively administered. Here, in a well equipped and appointed establishment, with expert sanitary officers and acclimated laborers, every vessel from an infected or suspected district or port could, with the least delay to travel and obstruction to commerce, undergo such treatment as would relieve her passengers and crew, cargo and ship of every particle of infection.

But if such sanitary precautions are not taken at the mouth of the river as, in the judgment of the health authorities of the valley, will intercept and exclude all infected persons and things from vessels from foreign ports, it is plainly the duty of such authorities to erect defenses looking to the same end within their own jurisdiction. Such measures must necessarily be cumbersome, as compared with the former, and far more obstructive of travel and commerce. Hence the only alternative is the organization of a system of inland inspection which shall intercept and quarantine infected persons and merchandise in transit, and furnish timely information to threatened communities. If neither of these measures are carried out in good faith, and infected merchandise is allowed to pass from commercial centers into the various avenues of trade, authorities are undoubtedly justified in forbidding its entrance into their communities, and in employing such agencies as will most effectually accomplish that object. The hardships which such stringent measures impose upon commerce are not to be considered, when they relieve public alarm and surely prevent both panic and a possible epidemic.

In conclusion, I may remark that the opinion of the health and civil authorities throughout the valley seem to be unanimously in favor of the most efficient quarantine establishment at the seaboard which modern science and adequate means can provide. It is the belief that if all further importation of yellow fever can be prevented, it will not be difficult to exterminate whatever germs may remain in this country. But it is not common justice to impose upon a single State the obligation of providing and maintaining a quarantine which protects ten populous States from the direct importation of yellow fever from foreign ports. Nor is it compatible with public safety to commit the administration of such a quarantine to the local influences which surround it. On the contrary, a quarantine which protects such an enormous population from pestilence, and such diversified industrial interests from depression, ought either to be established and maintained by the joint action of the several States interested, or by the general government.

Very truly, yours,

STEPHEN SMITH.

SICKNESS ON THE TOW-BOAT "RAVEN."

At 3 o'clock p. m., August 29, a cipher telegram was received by the director from Inspector Rice, at the Vicksburg inspection station, stating that he had removed five cases of suspicious fever from the tow-boat *Raven*, which boat left New Orleans August 24; that the captain refused to remain long enough to enable him (Rice) to decide as to the character of the sickness; that the rest of the crew, believing it to be yellow fever, threatened to desert the boat; and asking instructions as to the course to be pursued. He was at once telegraphed to hold the boat and all on board, if possible, until satisfied that she could proceed with safety to the public health; but that if there was danger of the possibly infected crew deserting to allow her to proceed after securing a promise from the captain to make no landing short of the Memphis inspection station. Meanwhile Inspector Reilly was instructed to have the sanitary patrol boat *Benner* in readiness to proceed, with all possible dispatch, down the river to intercept and take charge of the boat should she leave the Vicksburg station before the character of the sickness was determined. A second dispatch from Inspector Rice, announcing that the *Raven* had left the station, was received at 9 o'clock p. m., and the *Benner* departed forthwith upon her mission.

Dr. Reilly's orders were to the following effect:

OFFICE OF DIRECTOR RIVER INSPECTION SERVICE,
NATIONAL BOARD OF HEALTH,
Memphis, Tenn., August 29, 1880.

DOCTOR: The information telegraphed to-day by Dr. Rice, from the Vicksburg inspection station, renders it necessary that prompt action be taken to ascertain forthwith the exact condition of the tow-boat *Raven* and her barges. You will therefore take the sanitary patrol boat *Benner* with all possible dispatch down the river to intercept said boat. Should you find positive evidence of infection on board you will take possession of the boat and barges and enforce such measures as may be necessary to prevent any spread thereof to the shore at any point in the valley. You are intrusted with the widest discretion in the construction and fulfillment of this order.

Engage another pilot in addition to Captain Thompson, and two engineers, together with such other persons as may be necessary to enable you to run the boat night and day.

You will include the expense of hiring all these persons (other than those borne on the regular pay-roll of the boat) in your traveling expense account, as well, also, as any other expenditures you may find it necessary to make in the prosecution of this duty.

If it becomes necessary to take the *Raven* back to the Vicksburg station you will remain there long enough to assist Dr. Rice in getting the quarantine equipment of the station on a proper footing, and will correspond fully and promptly with this office, both by mail and wire.

As soon as possible you will return to Memphis, reporting in person to this office.

Very respectfully,

R. W. MITCHELL,
Member National Board of Health and Director River Inspection Service.

DR. F. W. REILLY,
Inspector, N. B. H., Memphis, Tenn.

The weekly report of inspections at New Orleans, received the next day, August 30, notes that one of the barges of the *Raven* had lain alongside a Spanish steamer, the *Yrurac Bat*, delivering wheat; and as this vessel had already been the subject of correspondence between the director and the Louisiana State board of health (on account of her discharging upon the New Orleans levee ballast taken in at Havana, an infected port), additional importance was thus attached to Inspector Rice's action.

The *Raven* was met and boarded about midnight of August 30, nearly opposite Lake Washington, Miss., some 300 miles below Memphis and less than 100 miles from Vicksburg. Two of her crew were reported sick, but upon examination one was pronounced a malingerer, and the other was found to be suffering from well-marked quotidian intermittent fever. The boat and barges were found in good sanitary condition, and she was allowed to proceed upon her voyage, with instructions to report at the Memphis inspection station for further orders. The *Benner* arrived at the Vicksburg station in the afternoon of the 31st August, and during the night returned to Vicksburg, whence the following dispatches were at once transmitted throughout the valley:

VICKSBURG INSPECTION STATION, N. B. H.,
August 31, 1880.

The cases from the tow-boat *Raven* have been under continuous observation during the past seventy-two (72) hours, and are now positively declared not yellow fever or other contagious disease.

C. A. RICE, M. D.,
Inspector, N. B. H.

U. S. STEAMER H. H. BENNER, N. B. H.,
Off Vicksburg, Miss., August 31, 1880.

I have personally examined the patients from the tow-boat *Raven*, and also the clinical record of said patients for the past three days, and fully concur with Dr. Rice in the above declaration.

F. W. REILLY, M. D.,
Inspection Service.

An examination of the clinical record of these cases fully justifies Inspector Rice in his action. It reveals a febrile disease of a single paroxysm of from sixty-eight (68) to seventy-two (72) hours duration, and during which the temperature rose to 105.5°, accompanied by a slow pulse (62–72); in one case, under observation from the beginning of the attack, the pulse was 92 and temperature 105°, eighteen hours after pyrexia began, and sank to 70, 68, 62, with a temperature ranging between 105° and 101.2°. For the rest there was supra-orbital headache, severe rachialgia, a white tongue with red edges and tip, gums very red and slightly swollen, conjunctivæ injected. At the close of the second day's observation, however, the following negations warranted the exclusion of yellow fever from the diagnosis: No epigastric tenderness or distress, no hemorrhages, no icterus, neither suppression of nor albumen in the urine even of the cases of longest duration (seven days). It is probable that the disease was dengue, which had already assumed epidemic proportions in New Orleans at the time the *Raven* left that port.

The cases were treated on the floating-hospital wards at the sta-

tion, and during the period of uncertainty no intercourse was allowed with the shore or with other vessels. Notwithstanding the precautions taken, however, and the commendable reticence of Inspector Rice, it was at once rumored that there was yellow fever at the Vicksburg station, and upon a tow-boat making her way up the river, as in the case of the *John D. Porter* in the year 1878. From Greenville to Vicksburg the river communities were found in a panic of alarm, and organizing "shot-gun quarantines." The passage of the *Benner* and a knowledge of her errand allayed this excitement, and the publication of the dispatches, above given, speedily restored confidence. This individual service is, in itself, ample return for the expenditure on account of the sanitary fleet.

VERDICT OF THE VALLEY UPON THE SERVICE.

With the view of ascertaining the estimates of the value set upon this service by those most directly concerned and best qualified to judge—such estimates to form the basis, in part, of any recommendations to the Board by the director—letters of inquiry were addressed to various organizations and representative citizens soon after the close of the season. In response thereto the following action and expressions were obtained:

Proceedings of the Memphis Cotton Exchange with reference to the protection of the public health.

At a called meeting of the Memphis Cotton Exchange, held this 30th day of October, 1880, the following proceedings were had:

The members were called to order at three o'clock, p. m., by the president, D. P. Hadden, who stated that the object was to consider and take action upon a communication from Dr. R. W. Mitchell, the resident member of the National Board of Health, and under whose direction had been conducted an inspection service which the speaker believed had been of inestimable value to Memphis and all other communities in the Mississippi Valley during the past summer. Without detaining the members, he would call on the secretary to read Dr. Mitchell's letter, which is here appended:

NATIONAL BOARD OF HEALTH,
INSPECTION SERVICE—OFFICE OF THE DIRECTOR,
Memphis, Tenn., October 28, 1880.

MY DEAR SIR: Before closing my final report upon the operations of the river inspection service of the National Board of Health for the season of 1880, I am desirous of obtaining a formal expression of opinion upon the merits and usefulness of the service, in order to guide me in my recommendations to the Board as to its future policy upon the question of continuing or relinquishing this branch of its work. As the representative commercial body of this city, it seems to me fitting that such expressions should be formulated by the cotton exchange; and I have, therefore, to ask that you present this communication to its members at your early convenience.

It is simply desired that the exchange state, by resolution or otherwise, whether the inspection service has proved to be of sufficient value to the commercial interests of Memphis and the Mississippi Valley to warrant the National Board of Health in maintaining it during the next season.

Very respectfully,

R. W. MITCHELL,
Member National Board Health, Director Inspection Service.

SAM. M. GATES, Esq.,
Secretary and Superintendent Memphis Cotton Exchange.

* * * * * * *

The president then asked the meeting what its pleasure was with reference to Dr. Mitchell's communication.

Mr. J. R. Godwin suggested that the letter be referred to a committee, with instructions to draft a report for the action of the members, and made a motion to that effect. The motion being seconded and unanimously adopted, the president appointed the following gentlemen: J. R. Godwin, of J. R. Godwin & Co.; H. M. Neely, of Brooks, Neely & Co.; Napoleon Hill, of Hill, Fontaine & Co.; J. W. Dillard, of Dillard, Coffin & Co.; and R. F. Patterson, collector of internal revenue.

* * * * * * *

[This committee subsequently reported through its chairman, Mr. Godwin, as follows:]

To the officers and members of the Memphis Cotton Exchange:

GENTLEMEN: Your committee, to which was referred the communication of Dr. R. W. Mitchell, asking "that the exchange state, by resolution or otherwise, whether the inspection service has proved to be of sufficient value to the commercial interests of Memphis and the Mississippi Valley to warrant the National Board of Health in maintaining it during the next season," beg leave to offer the following preamble and resolutions for the consideration and action of the exchange:

Whereas the Mississippi Valley has within the past seven years been afflicted with repeated epidemic visitations of yellow fever, which have caused an appalling loss of life, incalculable suffering, and severe, if not irreparable, injury to material interests; and

Whereas during the past critical period of 1880, there has been maintained by the National Board of Health an inspection service throughout the valley, from New Orleans to Cairo, which has preserved confidence, and so prevented panic and "shot-gun quarantines," and consequent interruption of business and commercial intercourse; and

Whereas it is manifestly impracticable for the States, or for communities, of themselves to maintain this service, which, to be efficient, must be free from local influences and uniform in its operations beyond State boundaries; and

Whereas we believe such service to be essential to the protection of the public health of this region, and especially to the prevention of the introduction and spread of yellow fever; therefore, be it

Resolved, That the Memphis Cotton Exchange recognizes in the National Board of Health an agency whose beneficent services to the whole Mississippi Valley cannot be overestimated, and which it is the duty of the general government to foster and maintain.

Resolved, That the Inspection Service of the said National Board of Health, as conducted during the past season, merits the unqualified approbation of every merchant, taxpayer, and citizen in the valley, to each and every one of whom it has been of direct personal benefit.

Resolved, That the National Board of Health be, and it hereby is, earnestly requested to continue said Inspection Service, and to establish and promote such other methods of sanitary work as may tend to redeem the Mississippi Valley from the scourge of epidemic diseases.

Resolved, That the secretary of the Exchange be, and he hereby is, directed to prepare for the signatures of members and others a suitable memorial to Congress, setting forth the substance of this preamble and resolutions, and asking for such legislation as may be necessary to make said Inspection Service permanent, to enlarge its scope, and to increase its efficiency.

Resolved, That the secretary be, and he hereby is, instructed to transmit a copy of the proceedings of this meeting to each Senator and Representative in Congress from the Mississippi Valley States, and to the various cotton exchanges, chambers of commerce, boards of trade, and kindred organizations in the same region.

J. R. GODWIN, *Chairman.*
H. M. NEELY.
NAPOLEON HILL.
JOHN W. DILLARD.
R. F. PATTERSON.

The report of the committee having been received, it was moved and seconded that the preamble and resolutions be adopted, as expressing the views of the members of the Memphis Cotton Exchange. The motion was carried unanimously, and the secretary was instructed to take such action as might be necessary to inform the specified individuals and organizations, and to secure concert of action throughout the valley.

DAVID P. HADDEN, *President.*

SAM. M. GATES, *Secretary and Superintendent.*

Similar action was taken by kindred bodies in Little Rock, Ark., Shreveport, La., Vicksburg, Miss., and elsewhere.

The following correspondence is also submitted:

NATIONAL BOARD OF HEALTH,
INSPECTION SERVICE—OFFICE OF THE DIRECTOR,
Memphis, Tenn., October 28, 1880.

DEAR SIR: Will you be good enough to favor me with your views as to the utility of the Inspection Service of the National Board of Health, stating whether, in your opinion, it has proved to be of sufficient value to commercial and railroad interests to warrant the Board in continuing it during another season?

I shall be largely guided by the judgment of yourself, and other representative men in the valley, in the recommendations which it is my duty to make to the Board in connection with the report of the operations of this service, which I am now about to submit.

Very respectfully,

R. W. MITCHELL,
Member National Board of Health and Director Inspection Service.

Maj. M. BURKE, *Supt. Miss. & Tenn. R. R., Memphis, Tenn.*

MISSISSIPPI AND TENNESSEE RAILROAD,
OFFICE OF THE SUPERINTENDENT,
Memphis, Tenn., November 3, 1880.

R. W. MITCHELL,
Director of Inspection Service,
National Board of Health, Memphis, Tenn.:

Your letter of the 28th ult., asking whether, in my judgment, the Inspection Service of the National Board of Health has been of sufficient value to commercial and railroad interests to warrant its further continuance, was received while I was engaged in completing my annual report to the stockholders of the Mississippi and Tennessee Railroad. I have deferred answer until I could furnish some figures to sustain my opinion.

I knew, in a general way, as I suppose all railroad men south of Saint Louis and west of Chattanooga know, that the confidence felt through the Mississippi Valley in the supervision and certificate system of the National Board of Health has been of signal benefit in

preventing panic and local quarantine on several occasions during the past summer, particularly in July last, when the Excelsior cases occurred in New Orleans, just about the time of the anniversary of the Memphis outbreak of yellow fever in 1879, and when every one in the Mississippi Valley was more or less apprehensive, and it would have been very easy to create a costly panic. At that time Grenada, the southern terminus of our road, and which suffered so severely in 1878, prepared at once to enforce a local quarantine, and would undoubtedly have done so but for the measures instituted by the National Board of Health. Quarantines are catching, and if Grenada had started one, the probability is that other places would have followed suit. The railroads know, to their cost, what such quarantines mean, and I believe it was the settled determination of some of the most important roads, in the event of their establishment as in 1878–'9, to run their engines into the yard, and not turn a wheel until the people had come to their senses.

Fortunately, no such emergency has arisen during the past year, and the following table and figures will show the difference in the results to this road:

Comparative statement of the business of the Mississippi and Tennessee Railroad for the years ending September 30, 1879 and 1880, respectively.

Cotton transportation.	1880.	1879.	Increase.
	Bales.	*Bales.*	
Shipments from local stations to Memphis	52, 919	49, 170	3, 749
Shipments from local stations to New Orleans	23, 292	13, 209	10, 083
Total local cotton	76, 211	62, 379	13, 832
Received at Memphis from line of C., St. L. & N. O. R. R.	1, 306	750	556
Forwarded from Memphis to New Orleans	95, 344	38, 879	56, 465
Total number bales transported	172, 861	102, 008	70, 853

It would be misleading to attribute all of this increase to any one cause, and it would be manifestly improper to compare 1879 with 1880 in order to determine the value of the Inspection Service, since in the former year Memphis was still closed by quarantine during the early part of the cotton-shipping season, and the injury to our business was due to this cause, and to the yellow fever in the city. Excluding Memphis on this account, and comparing only the local stations which were not affected by these conditions, it will be seen that the increase of 1880 over 1879 is + 76 per cent., and a very large share of this increase is undoubtedly due to the general sense of confidence which people had come to feel in the Inspection Service in 1880, and which thus preserved intercourse and traffic from interruption in that year. The service was too incomplete and too novel in 1879 to inspire this confidence, and as a consequence every town and village and railroad-crossing run an independent quarantine of its own, in the face of which it was almost impossible to run a railroad train.

This opinion is still further stengthened by comparisons of the passenger earnings and the freight earnings for the two years. Still excluding Memphis, for the reasons above given, the increase of our passenger earnings in 1880 over 1879 will be seen to amount to + 68 per cent. [See Table No. 3, Annual Report.] The freight earnings for local stations outside of Memphis nearly doubled in 1880 those of 1879, the increase being 97.7 per cent.—[See Table No. 6, Annual Report.]

I do not know that anything which I could say would add to the value of the testimony of these figures. But I have no hesitation in asserting that I believe it to be the duty of the National Board of Health to continue its Inspection Service, not only next season, but every season, until the valley is no longer liable to be visited by yellow fever. This assertion, I think, expresses the opinion of every railroad manager with whom I am acquainted.

Very respectfully,

M. BURKE, *Gen'l Supt.*

NATIONAL BOARD OF HEALTH,
INSPECTION SERVICE, OFFICE OF THE DIRECTOR,
Memphis, Tenn., October 28, 1880.

SIR: Before closing my final report of the river inspection service of the National Board of Health for the season of 1880, I would be glad to have an expression of opinion from you on the following points:

1. Has the service been of any advantage or benefit to you and the interests you represent? If so, please state briefly in what respect.

2. Is it desirable, simply for business considerations and aside from the health question, that the service be continued another year?

Very respectfully,

R. W. MITCHELL,
Member National Board of Health and Director Inspection Service.

Capt. AD. STORM,
Supt. Memphis and St. Louis Packet Co., Memphis, Tenn.

OFFICE OF ST. LOUIS AND VICKSBURG ANCHOR LINE,
MEMPHIS AGENCY,
Memphis, November 1, 1880.

SIR: Your favor of the 28th October was duly received. In reply, I would say that a continuation of the river inspection service, as conducted by you during the past summer, is highly desirable, because its operations preserve confidence along the river and prevent local quarantine orders, which have been the cause of serious losses, both to steamboatmen and shippers, in the past.

Such regulations as it is necessary to enforce for the protection of the public health being uniform under your service, we find it easy to comply with them, since we know what is expected, and can govern ourselves accordingly.

Formerly we very often learned of the regulations of a town only when the boat arrived at it, and was met with a board of health order forbidding her to put off freight or passengers.

It was a ruinous condition of affairs for all concerned, and I hope, in the interests of the line I represent, that your inspection service will be continued, in order to prevent a return to the old way.

Though there has been no yellow fever to speak of this year, it would have been very easy to get up a panic, which would have shut out our boats from many places during the summer months. I know that Cairo and some other towns would have quarantined against us if it had not been for the inspection certificates of your National Board.

I think we only escaped a panic on account of the tow-boat Raven by your prompt and decided action in sending the Benner down to intercept her.

In what I have written I think I represent the sentiments of all those interested in steamboating on the Mississippi River.

Hoping that you will continue your inspections in the future,

I remain, very truly, yours,

ADRIANCE STORM,
Superintendent.

Dr. R. W. MITCHELL,
Memphis, Tenn.

Col. J. C. Clarke, vice-president of the Chicago, Saint Louis and New Orleans, and of the Illinois Central Railroads, replied as follows:

CHICAGO, ST. LOUIS AND NEW ORLEANS RAILROAD CO.,
OFFICE OF THE VICE-PRESIDENT AND GENERAL MANAGER,
New Orleans, November 10, 1880.

MY DEAR SIR: I do not hesitate to say that in my opinion the National Board of Health, through its efforts and organization, has rendered important benefits to the people of the Mississippi Valley by providing the means to arrest the spread of infectious and contagious diseases, and so preventing panic and unnecessary interruption to commercial intercourse. It would be a calamity to have New Orleans, Vicksburg, Memphis, and the whole Mississippi Valley deprived of the efficient aid and services of the National Board of Health, its inspection system, and information and recommendations concerning sanitary regulations.

Very truly, yours,

J. C. CLARKE,
Vice-President and General Manager.

Dr. R. W. MITCHELL,
Memphis, Tenn.

F. de Funiak, general manager of the Louisville and Nashville, and Nashville, Chattanooga and Saint Louis Railway Companies, hopes that "the Board will keep on with the good work it has engaged in."

D. W. C. Rowland, general superintendent of transportation of the Louisville and Nashville Railroad, writes: "My opinion was lately asked upon this subject, and I replied that I did not think it good to relax any work that was set in motion against the yellow fever; at least until we are a great deal further from the epidemic than now. We are all apt to forget these things and to relax vigilance as soon as the immediate danger is past. I would by all means keep the inspection service alive."

J. T. Harahan, superintendent Memphis divison Louisville and Nashville Railroad, says: "I am decidedly of the opinion that the work laid out and carried forward this year by the National Board of Health should not be stopped, but should by all means be continued.

* * * As far as this road is concerned, the National Board rendered valuable assistance in keeping up communication with Memphis, and the inspection syst. m was of great benefit to the commercial and railroad interests which this line serves."

John A. Grant, general superintendent of the Memphis and Charleston Railroad, writes: "My own opinion is that the inspection service should be continued, even if there are doubts as to its necessity, as it is certain that if there is an error it is on the right side."

Among other expressions is the following from representatives of the principal coal merchants and packet companies of Pittsburgh, Pa:

"The undersigned, owning and representing coal interests, steamboats and tow-boats plying on the White, Arkansas, Ohio, and Mis-

sissippi Rivers, and whose business in former years has been seriously injured by yellow fever, consider the inspection service of the National Board of Health invaluable, and under the regulations of this year it has been so ably managed as to avoid all the trouble and delay of former years when local boards had control. We believe the service necessary for the health and prosperity of the Ohio and Mississippi Valleys, and earnestly pray for a continuance of it."

Signed by A. J. McConnell, for Saint Louis and Huntington Packet Company; James Rees, Duquesne Engine Works; J. T. Stockdale, superintendent Pittsburgh and Cincinnati Line; R. C. Gray, Gray's Iron Line; John A. Wood & Son; G. J. Grammer, superintendent Evansville and Cairo Packet Company; O'Neil & Co.; W. J. A. Kennedy, secretary Cumberland Tow-Boat Company; Joseph A. Stone, for Coal Valley Coal Company; W. H. Brown, by Harry Brown; Joseph Walton & Co.; Simpson Horner & Sons.

From Vicksburg, Capt. E. C. Carroll writes: "I represent here three important lines of steamers, viz, the Saint Louis and Vicksburg Anchor Line, the New Orleans Anchor Line and the Parisot Line of Yazoo and Sunflower River boats, and think the service established by the National Board of Health has been of incalculable benefit to all. It seems to meet a serious want in properly caring for the sick and preventing excitement and alarm over suspicious cases. In a business point of view, its value and usefulness are obvious, and I heartily recommend that the service be continued.

Similar letters have been received from John N. Harbin, superintendent Memphis and Pine Bluff Mail Line; J. D. Randall, superintendent Memphis and Saint Francis River United States Mail Line; James O'Neal, superintendent New Orleans Anchor Line, Saint Louis; James H. Pepper, master James Howard; H. W. Brolaski, master John B. Maude; E. C. Postal, master Hard Cash; J. C. Coghill, master Belle of Shreveport; Stack S. Lee, master James Lee; Thomas L. Davidson, master Centennial; J. W. Bryan, master Commonwealth; Alex. M. Halliday, master Paris C. Brown; George Malone, master Coahoma; Mark R. Cheek, master Dean Adams; Ed. Nowland, master Katie Hooper; J. C. McCord, master Gold Dust; Albert Stein, master Charles Morgan; and others.

From Saint Louis: John A. Scudder, president Anchor Lines; H. Lowrey, President Saint Louis and New Orleans Transportation Company; Henry C. Harstick, vice-president Mississippi Valley Transportation Company; John P. Keiser, superintendent Vicksburg Anchor Line; James O'Neal, superintendent New Orleans Anchor line.

Following is the text of the memorial prepared and circulated by the Memphis Cotton Exchange:

"MEMORIAL.

"*To the Senate and House of Representatives of the United States:*

"We, the subscribers, citizens of the United States, and residents of ———, in the county of———, and State of ———, do respectfully represent that:

"Whereas the Mississippi Valley has been repeatedly afflicted with visitations of epidemic yellow fever, which have not only caused great loss of life, bodily and mental suffering, and destruction of material interests in the region aforesaid, but have also injuriously affected the country at large, so that the evil is a national one, and as such comes within the purview of the national Congress; and

"Whereas during the past dangerous season of 1880 there has been maintained by the National Board of Health an inspection service of sanitary supervision throughout the valley from New Orleans to Cairo, which operated to prevent the introduction and spread of epidemic, contagious, and infectious diseases, and, during the past critical season, has preserved confidence and prevented panic and "shotgun quarantines," with their consequent interruption of business and commercial intercourse; and

"Whereas it is manifestly impracticable for the States or for communities of themselves to maintain this service, which, to be efficient, must be free from local influences and uniform in its operations without regard to State boundaries; and

"Whereas, we believe such service to be essential to the protection of the public health of this region, and especially to the prevention of the introduction and spread of yellow fever;

"Therefore we, your petitioners, do earnestly pray for such legislation as in the wisdom and discretion of your honorable body may be deemed necessary to make said inspection service permanent, to enlarge its scope, and to increase its efficiency."

This has been signed by the president of the Merchant's Exchange of Saint Louis, the officers of all the Saint Louis transportation companies, public officials and representative citizens of that city; by the officers of the cotton exchange and representative citizens of Memphis; by merchants, bankers, railroad and river men and others of Cairo; by the officers and members of the cotton exchange, and the mayor and other officials of Little Rock; by the governor and every State official of Arkansas; and by similar representative citizens in Vicksburg, Shreveport, and many other places.

The memorials signed in Memphis have already been forwarded to Congress with the following letter:

DEAR SIR: The accompanying memorials are the result of a meeting of the Memphis cotton exchange, held October 30, 1880, and a report of which will be found in the inclosed pamphlet. Similar memorials from Shreveport, Vicksburg, Natchez, and elsewhere, will, I am informed, be forwarded from those places to other members of Congress. I take the liberty of sending these to you as the representative of a State and community directly and vitally interested in the subject-matter of the petition. From such acquaintance as I have with your public career, I believe you will willingly lend your influence and good offices to promote the object of the memorialists. Just what legislation may be needed in the premises it is not undertaken to say. Your position and opportunities will enable you to decide this. All that we, as citizens of the great valley, ask is that an agency which has preserved confidence and prevented needless interruption of business during the past year, may be continued in the future. That this is asked as directly in the interest of New Orleans and Louisiana, as of any other city or State in the valley, is hardly necessary to say.

I am, sir, very respectfully,

DAVID P. HADDEN.
President Memphis Cotton Exchange.

Hon. RANDALL L. GIBSON, M. C.,
Washington. D. C.

In view of the actions taken by the several bodies hereinbefore set forth, and the great service rendered to the commerce of the Mississippi Valley, I respectfully submit the following recommendations:

1. That the Mississippi River inspection service of the National Board of Health be continued, inspections to begin promptly on the 1st day of May, and to be maintained during the summer and autumn until there is no longer danger of an epidemic spread of yellow fever.

2. That the service be extended and made continuous, under one supervision, from Cairo, Ill., to the Gulf.

3. That a fully-equipped inspection station be established and maintained at a suitable point on the Mississippi below New Orleans, and as near the mouth of the river as practicable. Such station could, probably, be made legally operative only through the invitation and by the proper action of the Louisiana State board of health; but it is understood that such invitation and action are already contemplated, and that the Mississippi quarantine station of that Board may be converted into a station of inspection only, infected ships not to be retained in the river but to be sent to Ship Island for treatment. In the equipment of this station, therefore, there should be provided a powerful sea-going tow-boat, capable of handling any infected vessel and towing her to the Ship Island quarantine station. Failing the necessary action by the Louisiana State board, it is then recommended:

4. That a *service of observation* be maintained on the river between New Orleans and Port Eads, by means of a suitable patrol boat in charge of a vigilant inspector, whose duty it should be to promptly notify the National Board, and the various State and municipal boards in the valley above New Orleans, of threatening danger from infected vessels or other sources. For this service there is already sufficient legal authority in the action and attitude of the State and municipal boards of Mississippi, Tennessee, Arkansas, Kentucky, and Illinois.

5. That inspectors for duty in this service be hereafter appointed only after a proper examination—inspectors to be continued on reduced pay when not on active duty. (It is believed that desirable officers can be permanently secured if it were understood that the minimum rate of pay would be, say, $200 per month for six months of active service, and $100 per month when not on active duty.)

6. That substantial and suitably-equipped hospital-floats be provided for each station for the care and isolation of those suffering with infectious or contagious diseases, or suspected of being so affected.

7. That ready-made portable frame huts or houses be provided for the shelter of the inspectors and employés at the stations where there are no suitable structures otherwise provided—this in order to preserve the health and working efficiency of the force.

8. That the sum of $75,000, or so much thereof as may be necessary, be appropriated for the maintenance of said service and for the purposes above set forth.

All of which is respectfully submitted.

R. W. MITCHELL,
Member National Board of Health.

Dr. T. J. TURNER,
Secretary National Board of Health, Washington, D. C.

SUPPLEMENT No. 13,

National Board of Health Bulletin.

WASHINGTON, D. C., SATURDAY, APRIL 16, 1881.

THE RELATION OF SOILS TO HEALTH.

A preliminary Report to the National Board of Health.

FILTERING CAPACITY OF SOILS.

[By RAPHAEL PUMPELLY, assisted by GEORGE A. SMYTH, Ph. D.]

NEWPORT, R. I., *March* 28, 1881

MY DEAR SIR: About a year ago I had the honor of addressing a letter to you requesting the aid of the National Board of Health in carrying on a series of investigations into the relations of different soils to the air and water currents passing through them. My object was to aid in establishing upon an exact basis the practically important department of sanitary geology.

The immediate subjects to be studied in soils of different composition and structure were:

1. The rates of flow of water and of air under given conditions.
2. The capacities of soils as filters in eliminating organic and inorganic substances from liquids.
3. Their capacities as filters in eliminating the living low forms of vegetable life, both germs and adult organisms, from ground-water and ground-air.

The National Board of Health very liberally enabled me to undertake this work by agreeing to pay the salary of a chemical assistant and the necessary expenses.

I was fortunate in being able to associate with myself Prof. George A. Smyth, to whose skillful and delicate manipulation the successful issue of our joint work is largely due.

It is proper that I should state here that although the methods of attacking the above-mentioned problems, and the invention of the apparatus were the result of frequent consultations between us, the actual laboratory work has been wholly performed by Prof. Smyth.

Although it was my intention that the proposed investigations should be conducted as far as possible in the ground itself, upon undisturbed soils, it was necessary to first study in the laboratory the behavior, in their pure state, of the separate constituents of soils, quartz, sand, clay, loam, marl, loess, &c.

Yours, respectfully,

RAPHAEL PUMPELLY.

To the PRESIDENT *National Board of Health,*
Washington, D. C.

GENERAL RESULTS.

Thus far the work has been confined to the soils and some other substances as filters in eliminating living low vegetal organisms from air and fluids, and in this direction we have only made a beginning.

The great practical importance of this part of the subject led to its being considered first. The weight of authority among students in sanitary science is in favor of recognizing some genetic relation between the lower vegetal organisms and the epidemic prevalence of certain diseases. It is known that these low forms of life are capable of being carried in fluids and of floating in the air where, owing to their almost infinitesimal lightness, they are buoyed up by the slightest currents.

It has long been known that certain soils in time lose their ability to filter out the impurities from polluted waters. Many cases of disease are supposed to have been traced directly to the use of water containing sewage that had passed for a greater or less distance through the soil.

Again, it is an established fact that the air with which the soils are permeated above the surface of the ground-water vibrates to every barometric change in the outer atmosphere; that it moves in currents caused by this sympathy and by thermometric differences. And Pettenkofer and others have called attention to the importance of these currents of ground-air from a sanitary point of view.

When we consider that every vault, cesspool, and cemetery is a center of pollution to the ground water which supplies our wells, and, to a certain extent, also the reservoirs for cities, we can appreciate the importance of ascertaining to what extent soils are capable of eliminating the injurious properties contributed by the pollution.

Through the cellars our houses become, especially in winter, the ventilating chimneys for the surrounding ground; sucking in from all directions the air that has been nearly stagnant in the pores of the soil during the summer. In view of the fact that the ground-air is polluted by vaults, cesspools, and cemeteries in the country, and by the garbage of made ground and defective drains and sewers in cities, it is important that we should determine the extent to which different soils are able to filter the injurious properties out of the air passing through them.

In working toward the solution of these problems, our apparatus has consisted essentially of two parts:

1. The substance to be tested as a filter.
2. An infusion of beef, or some other easily putrescible substance.

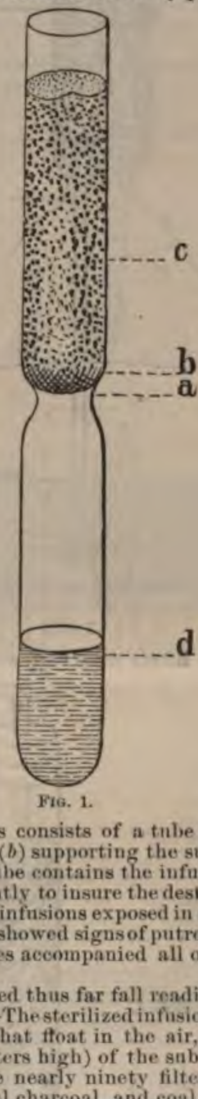


FIG. 1.

In the simplest form this consists of a tube with a neck (*a*), on which rests a copper gauze (*b*) supporting the substance to be tested (*c*); the lower end of the tube contains the infusion (*d*). The whole apparatus is heated sufficiently to insure the destruction of any germs or adult bacteria. Similar infusions exposed in open capsules unprotected to the air invariably showed signs of putrefaction within forty-eight hours. Such exposures accompanied all of our experiments as control tests.

The experiments conducted thus far fall readily into four classes.

I. DRY FILTERS FOR AIR.—The sterilized infusion was protected from the germs of putrefaction that float in the air, only by the column (1 millimeter to 17 centimeters high) of the substance to be tested.

In this series there were nearly ninety filters tried of asbestus, sand, loess, charcoal, animal charcoal, and coal ashes. After standing three to eight months, omitting four defective and one doubtful case, the infusions used are *all* sound, excepting where the filter was coarse sand (10°–20°, i. e., 10 to 20 grains to an inch), or animal charcoal that would just pass through a sieve of 15 meshes to the inch.

II. WET FILTERS FOR AIR.—These differed from the first only in having the filters saturated with sterilized water. The same materials, except coal ashes, were used as for the dry filters, and disregarding one doubtful and five defective cases, all have proved perfect protectors to the infusion beneath them, except two filters of coarse animal charcoal (15°), and one of loosely-packed asbestus, which failed to protect the infusions, perhaps owing to absorption of the water and conversion into dry filters.

III. QUANTITATIVE EXPERIMENTS FOR AIR WITH DRY FILTERS OF SAND, ASBESTUS, AND ANIMAL AND VEGETABLE CHARCOAL.—Fig. 2 shows the apparatus employed.

In these experiments an artificial current was produced, the air being sucked by an aspirator connected at *f* (see Fig. 2) through the filter (*c*) and into the infusion (*d*).

In one set of these experiments the air was passed through in a slow current—1 to 6 liters in 24 hours. These experiments were started at different dates between June 19 and October 30, and subjected to continuous currents. One filter, loosely-packed asbestus, 5 centimeters high, has failed after passing 89 liters of air. It will

be seen from the tables that the others are still fresh (February 10) after passing 180 to 434 liters.

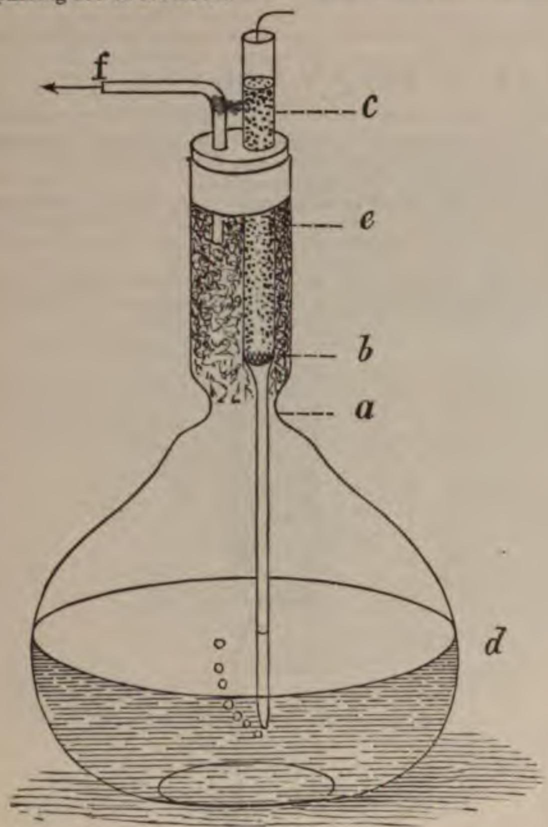


FIG. 2.

In another set the filters were subjected at intervals during five

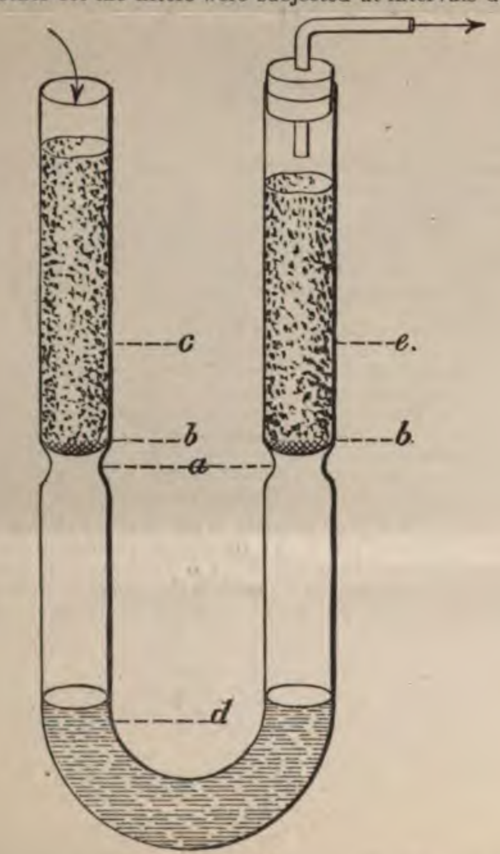


Fig. 3.

months to rapid currents, beginning at the rate of 1 liter in 4 to 7½ hours and increasing to 1 liter in 1½ minutes. These filters (Fig. 3) consisted of columns *c e*, 10 centimeters high, of sand, 30° to 50°—*i. e.*, screened through 30 to 50 meshes per inch.

Sand 100°.

Asbestus packed rather tightly.

All the filters have stood this extremely trying test, the infusions remaining intact.

These experiments go to show that as long as the grains are small all the substances tested filter perfectly all organisms from the air passing through them.

IV. EXPERIMENTS IN FILTERING BACTERIA AND THEIR GERMS FROM LIQUIDS.—In these experiments there were tried (see Fig. 1) three sets of filtrations, the liquids being respectively:

a. Fresh infusions.
b. Putrid infusions.
c. And water.

In the first set the filters employed were sand, charcoal, and animal charcoal, the finest of each being 100°, and asbestus in columns of 15 centimeters. All failed to filter out the germs except two filters out of twelve of asbestus and the finest animal charcoal; the remaining asbestus and coarser animal charcoal 15° and vegetable charcoal in all grades failing equally with the sand.

Similar filters were used in the second set (filtration of putrid infusions), except that of charcoal filters nothing finer was used than vegetable 25° to 50° and animal of 15°

In this set only tightly packed asbestus stood the test; in all the others the infusion passed through turbid.

But it will be noticed that in the previous set the finest animal charcoal filtered perfectly an infusion that became putrid during the process.

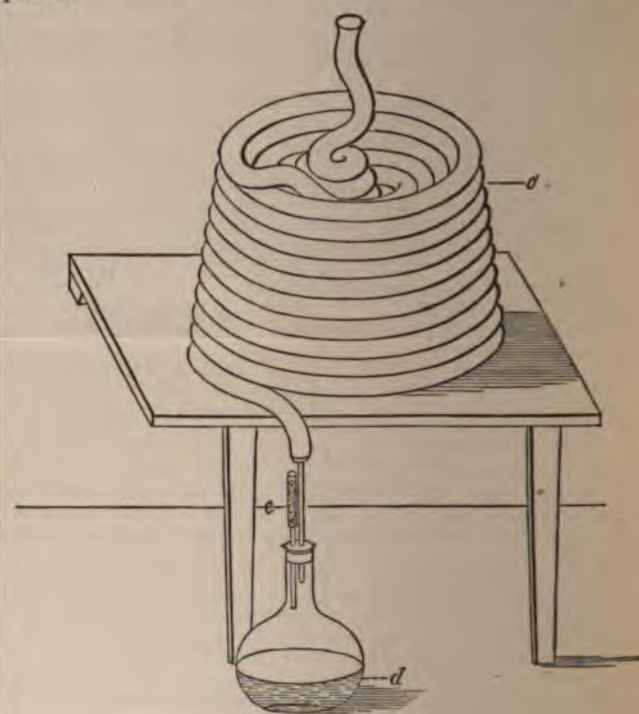


FIG. 4.

In the third set (filtration of water) the substances tested were columns 15 centimeters high of:

Asbestus, tightly packed.
Charcoal, 25° to 50°, and others of 100°.
Animal charcoal, 15°, and others 100°.
Loess from near Council Bluffs, Iowa (taken 40 feet below the surface).
Kaolin.
One part Kaolin, three parts sand.
One kaolin, one sand.
Coal ashes, 10° to 100°.
Sand 25° to 30°, 30° to 50°, and 100°.

The experiments were conducted so that only a drop or two of water should reach the infusion at first; more water being passed after intervals of several days, where the infusion remained uninfected.

Of these the tightly packed asbestus stood repeated filtrations during 10 days, after which the infusion putrefied.

Of the finest animal charcoal filters one out of four filtered out the germs.

The other three stood repeated filterings during 17 to 20 days, after which the infusion became infected.

The coal ashes were subjected to repeated filtrations during 10 to 19 days, after which the infusions putrefied.

The infusions under the loess filters broke down after from 6 to 8 days.

Those under the kaolin and the mixtures of kaolin and sand all broke down after from 1 to 8 days (although only a few drops had passed in each case), excepting one out of six of pure kaolin, which kept for 19 days, and one out of six of kaolin and sand, in equal parts, which kept 20 days. In all others, the first drop that passed through infected the infusion. And it is probable that in the repeated filtrations, except in the one case of the finest animal charcoal, there was either a differential filtration, or that only so few germs succeeded in passing that a much longer time than usual was required for the infusion to assume the opalescence that betrays infection.

We now made a bold jump from columns of 15 centimeters to columns of 22 and 100 feet.

Of these we have thus far tried only sand of mixed grain 18° to 100°.

To obtain sterilized columns of such a length the sand was intensely heated and poured into lead pipe *c* (Fig. 4), which was then coiled. It was then placed in a furnace and heated to between 250° and 300° C., and then the lower end attached to the flask containing the infusion *d*, and ventilated through a tube protected by sterilized asbestus, *e*.

The whole was then allowed to rest several weeks to be sure that the infusion had been properly sterilized. The pipe was then very slowly filled with tap-water. *The first water that passed through each of the 22 and 100 foot columns carried infection with it.*

Although our experiments have thus far been more of a tentative character, and preliminary to quantitative work, they permit us to draw a few sharply-defined conclusions:

I. All the substances operated on are excellent filters in eliminating germs from *infected air* passed through them, except when they are of a coarse grain 10° to 20°, when the interstitial cavities become probably much less labyrinthine. And all these filters withstood the

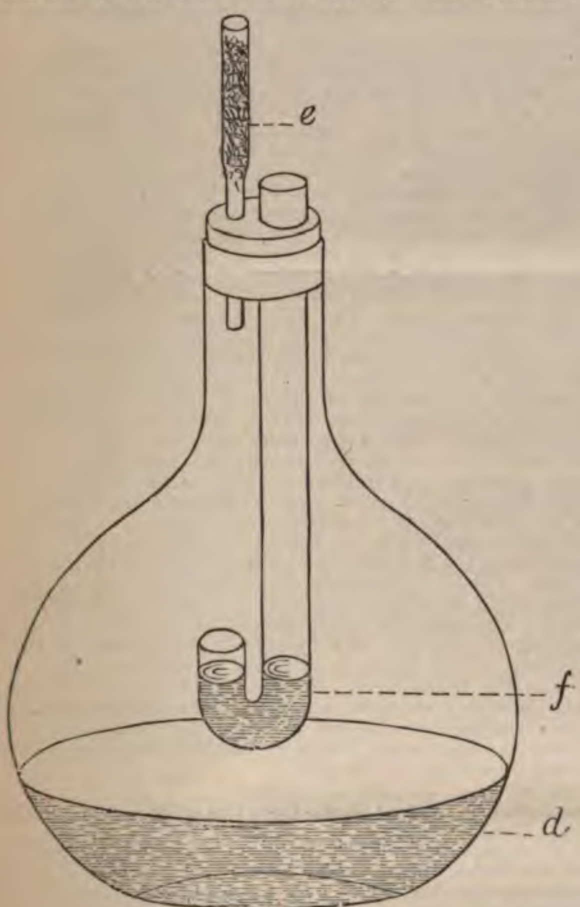


Fig. 5.

test of currents having many thousand times the maximum velocity attained in the soil.

II. All natural substances tried thus far, except the finest animal charcoal, and perhaps tightly-packed asbestus, failed to eliminate wholly the germs from liquids.

In the only natural soils tried, the sand, loess, and kaolin, we find in the sand an absolute absence of filtering power as regards germs in water, which would probably be as evident in columns of 10,000 feet as of 100 feet. In the loess, and in the much more compact kaolin on the other hand, there is evidence of a greater filtering power. In these cases it is not unlikely that we shall find that somewhat longer columns will eliminate the germs from the first water passing through; and that with them the filtering capacity is merely a question of the relation of length of column to amount of water.

At this point in our work, it seems as though the filtering capacity were wholly dependent on the size and intricacy of the interstitial cavities; and that in dry-air filters there is a critical limiting point beyond which there is no filtering.

And the same remarks seem to be true in different degrees with regard to the filtration of liquids. Here far greater fineness and compactness of grain and intricacy of passage are needed than are requisite for air filtration. While sand of 20° is an excellent air filter, sand of 100° in long columns is worthless for water, and the critical limiting point below which soils begin to exercise any filtering action probably verges on the size of grain in an impalpable powder.

From these results it appears very clearly that sand interposes absolutely no barrier between wells and the bacterial infection from cesspools, cemeteries, &c., lying, even at great distances, in the lower wet stratum of sand. And it appears probable that a DRY GRAVEL ***or possibly a*** DRY VERY COARSE SAND ***interposes no barrier to the free entrance into houses built upon them of these organisms which swarm in the ground-air around leaching cesspools, leaky drains, &c., or in the filthy made-ground of cities.***

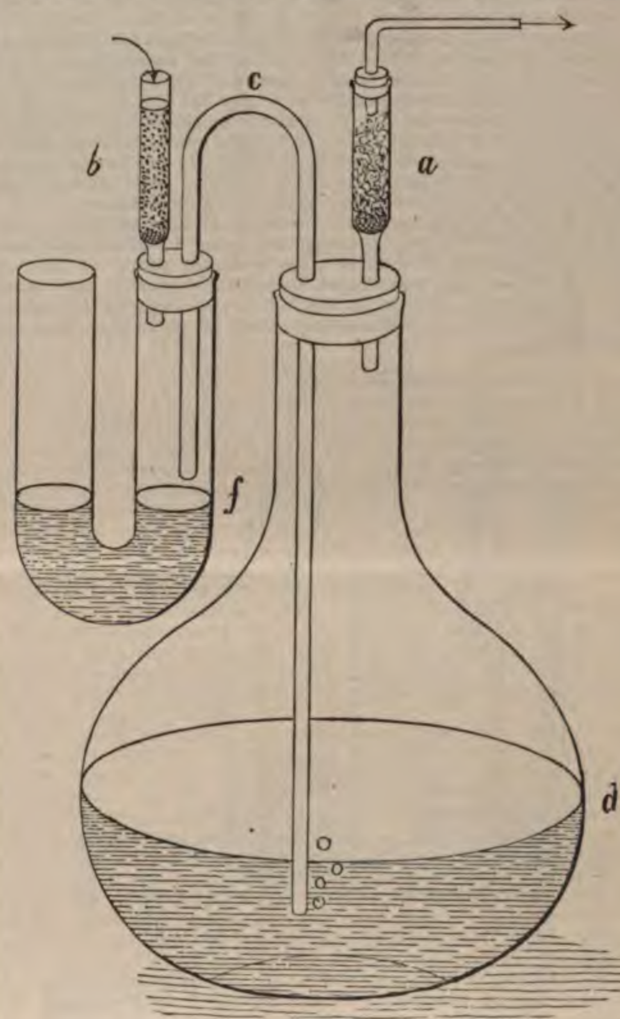


Fig. 6.

And from the results obtained from the two series of experiments, viz, in filtering air and in filtering water, we can now draw one very important practical conclusion which cannot be too strongly emphasized: *That a house may be built on a thoroughly dry body of sand or gravel, and its cellar may be far above the level of the ground-water at all times, and it may yet be in danger of having the air of its rooms contaminated by the germs from leaching cesspools and vaults; for, if the drift of the leaching be toward the cellar, very wet seasons may extend the polluted moisture to the cellar walls, whence, after evaporation, the germs will pass into the atmospheric circulation of the house.*

We are, however, only at the beginning of the subject. Our next studies will be in part the determination of influence of size of grains and character of interstitial passage; the influence upon the germs of length of time occupied in transit; of temperature and pressure,

and of presence or absence of nourishment in the liquid. And all of our experiments will be extended to the different soils and to some porous rocks. We are also about to determine the presence or absence of germs at various depths in different soils.

The important question now in controversy regarding the ability of germs or bacteria or other particulate matter to disentangle themselves from a liquid, and become suspended in the atmosphere, has an important bearing upon the relation between ground-water and ground-air.

For this reason we have carried on several series of experiments in this connection.

Referring to the full description of the methods and apparatus for details, I will give here only a general outline, with the results.

I. In the first series (see Fig. 5) water, sewage, and putrefied substances (*f*) were suspended in flasks over a sterilized beef infusion (*d*) in a room where the temperature ranged between 20° and 35° C. At the end of 80 days the infusions were intact.

After the furnace fire was started in the autumn, the heat from the register which was below the flasks seems to have caused the transmission of the infection from the water and putrid infusions to the infusion in three out of five flasks, while the remaining two are still intact after five and six months, respectively, although repeatedly exposed to temperatures of 37° to nearly 42° C.

II. In another series (see Fig. 6) of three flasks, during more than a month, air filtered through asbestus (*b*) was aspirated from immediately above the surface of the infected fluid (*f*) and made to pass through the infusion (*d*) at the rate of 3½ liters per day. In all three flasks, after nearly six months, the infusion is still intact.

III. A third series was instituted to determine the possibility, suggested by Colonel Waring, of germs becoming liberated from the liquid by the bursting of bubbles of gas or common air.

For this purpose air was drawn by extremely gentle aspiration (Fig. 7) through the sewage (*f*), the bubbles breaking in the atmosphere above, whence the air was aspirated, so as to pass through the infusion (*d*).

FIG. 7.

Although the formation of the bubbles was gentler than in much natural fermentation (only two-third liters, in some cases per day being aspirated), the infusion in all three flasks became infected within a few days.

These results are positive as far as they go, and show that particulate matter, however minute, cannot pass from the surface of a quiet liquid into the atmosphere under the conditions surrounding our experiments, whereas, on the other hand, the bursting of even the gentlest bubbles can effect such a transfer. They are not, however, sufficiently positive with regard to higher temperatures; needing to be repeated in breeding boxes at regulated temperatures.

Experiments are also needed as to the effects of growths of mould on the surface in forming a transitional condition from which a transfer might be effected; also as to the influence of the evaporation to dryness of infected moisture raised by capillary attraction.

We are indebted to Dr. Sternberg, U. S. A., and to Dr. W. S. Bigelow, for important aid in microscopic examination.

DETAILS OF THE WORK, WITH TABLES.

In studying the deportment of soils and of artificial filters, with reference to the transmissions of germinal forms of matter, two general series of experiments suggest themselves:

1. *On their action as filters for air or gases generally.*
2. *On their action as filters for water and other liquids.*

FIRST SERIES OF EXPERIMENTS—AIR-FILTRATIONS.

We have in this series two problems to solve:

1. *Whether the filters employed will protect the infusions when the vessels containing them simply stand exposed to the air,* when the air-currents consequently are very feeble, being induced by slight fluctuations of temperature, pressure, &c., of the atmosphere.

As the filtering capacities of the materials employed are affected both by the length and the porousness of the filtering column, the experiments should be tried with filters of varying thickness, and of different degrees of compactness, in the case of fibrous filters as asbestus, or of different degrees of fineness, in granular filters as charcoal, sand, &c.

2. *Whether the filters will protect the infusions when air is forced through them.*

Here we have to determine how great a volume of air can be conducted through filters of a certain length and of varying degrees of compactness or of fineness in a slow and uniform stream, and again how rapidly a given volume of air can be filtered.

Furthermore, as the experiments have a practical bearing, they should be tried under all the natural conditions of the soils as regards moisture, *i. e.*, with dry, partially saturated, and completely saturated filters.

The results of the experiments, so far as we are prepared to communicate them, are given in the tables below, which contain the full data. Table I contains the tests of the first problem with dry filters; Table II, with wet filters; while Tables III and IV give respectively the results of slow and rapid filtrations. Accompanying these tables are graphical representations of the lengths of time during which the different infusions have remained fresh. The figures on the horizontal lines represent days (in Table II, first series, weeks), the vertical lines the number of days and parts of days, therefore, that the infusions remained intact. The times given are the periods between the preparation of the experiments and the first appearance of decomposition to the naked eye. Where this could only be told within certain limits dotted lines in continuation of the vertical lines represent the extreme limits. The lines running above the scale and terminating in arrow-points denote infusions which are still clear.

With the dry filters we have experimented, as will be seen, with asbestus, sands and charcoals (both vegetable and animal) of various degrees of fineness, mixtures of sand with clay in different proportions, pure clay, coal-ashes, and one natural soil, a loess from the vicinity of Council Bluffs, taken some forty feet below the surface. As wet filters asbestus, sand, charcoals, and loess have been tried. For slow quantitative filtrations dry abestus, sands, charcoals, and for rapid filtrations dry asbestus and sands have been tested.

For asbestus filters the so-called *carded asbestus,** which can now be obtained commercially, was employed. For sand filters the very pure sand from the Berkshire sand-works has up to the present time been used. This is a very pure, crushed quartz. For animal charcoal filters both bone-black and very fine charcoal from blood, &c., was used. The sands and charcoals employed were carefully sifted through sieves containing ten to one hundred meshes to the inch. The fineness of the sands is indicated in degrees. Thus a sand marked in the tables 25–30°, for instance, is one which will pass entirely through a sieve containing 25 meshes to the inch, and be retained completely by a sieve of 30 meshes to the inch; sand marked 100° contains sand of every degree of fineness, above one-hundredth of an inch up to the finest powder.

Table I, first series—Dry filters.

For these experiments, tubes (Fig. 1), with a contraction in the middle and flasks, with the necks contracted at the base, for the purpose of supporting the filters, were employed. In three of the first experiments with sand filters the necks of the tubes employed were plugged with a little asbestus, the sand being filled in on to these, but as it seemed possible that these simple plugs might themselves act as filters, in all subsequent experiments disks of fine copper gauze (ordinarily of 80 meshes to the inch), of a diameter somewhat

* The use of asbestus in this form for the purpose of preserving infusions in bulk for subsequent experiments cannot be too highly recommended, as the carded asbestus is as convenient and serviceable a filter as cotton, and can be at once sterilized by direct ignition in the open flame of the burner. It has been our practice to prepare the infusions for experiments in quantity, to store them in large flasks, the necks of which were then loosely stoppered with a wad of asbestus. Although some of these flasks have been repeatedly opened, while others have remained undisturbed for weeks, we have never had in either case an infusion decompose. It is simply necessary after using a portion of an infusion for experiments to reboil the remainder and reinsert the freshly ignited plug of asbestus.

may have gone on for some time before it became sufficiently marked to be detected, and the dates given in the tables would not then indicate even approximately the times of incipient decomposition. It certainly would not be impossible for this to happen, for the bacterial growths themselves could not be detected as in the transparent infusions of beef, hay, &c., through a cloudiness of the liquid, the formation of pellicles on its surface or a mere film on the glass at the edges of the infusion, but their presence could only be discovered through the precipitation of casein, in consequence of the lactic acid or butyric acid fermentation, &c., or through the formation of putrefaction products in large amounts.

It must, however, be observed that, after the first indications of souring or of putrefaction, the decompositions proceeded with marked rapidity, especially in No. 112.

Periodical microscopic examinations are evidently necessary in all filter experiments with milk in order to fully control the results, and in future tests we shall consequently so modify the apparatus as to admit of microscopical examinations without at the same time disturbing the filters. The necessity of microscopical examinations becomes more apparent from an examination of the experiments, Nos. 107 to 109 and 113 and 114.

The decompositions which have here taken place are more difficult still to account for. The milk in these flasks appeared to have remained unchanged for several months; small quantities of casein separated out very slowly, in somewhat granular masses, which remained for the greater part suspended. There were no indications of lactic acid fermentation or of putrefactive decomposition, nor could traces of vibrionic growths or of bacteria of decomposition be found under the microscope, with the aid of a Zeiss one-twelfth inch homogeneous oil-immersion objective, in Nos. 107 and 113, which were opened and examined January 22.

These had, however, an acid reaction, a peculiar, disagreeable, oily odor and taste, somewhat like that of stale, unsalted butter, and contained some spherical cells closely resembling colostrum-corpuscles, which were stained by anilin-violet. They had evidently undergone some chemical change. Exposed to the air they underwent the usual fermentation, the casein coagulating in thick curds.

Similar results were obtained from the examination of No. 114 in February (Hartnack, nine, water-immersion objective).

Nos. 108 and 109 gave the same oily odor, &c., but have not as yet been examined microscopically. With these we shall try cultivation tests.

These changes must have taken place either without the action of inferior organisms, *i. e.*, through strictly chemical processes, or else through the development of some form or forms of organisms in so inconsiderable a degree as to escape detection.

Besides the experiments just discussed, several tests (Nos. 35 to 58) were tried with unsterilized filters of sand, asbestus, and cotton for comparison with these, the object being to learn whether the germs which these bodies undoubtedly contain in consequence of their previous free exposure to the air would readily be detached from them and fall into the infusions in the tubes and flasks. For all germs deposited upon them from the air, after their insertion into the filter-tubes, they would act as filters as well as the sterilized materials, and only those germs adhering to the lower layers as the tubes were filled could become detached and fall into the infusions. A slight modification in the method of experimentation is here obviously necessary; for should the infusion be maintained at the boiling temperature during and subsequent to the addition of the filters, the germs adhering to their lower surfaces might be destroyed by the steam; while, on the other hand, should the infusions be allowed to cool, wholly or in part, previous to the insertion of the filters, there would be no guaranty that germs had not entered from the air.

In the series of flasks (Nos. 35 to 46) the filters were added directly the infusions ceased to boil after the removal of the flame. The series of tubes (Nos. 47 to 58) were partially cooled directly beneath the flame of a burner, so that the air on entering first passed through this, and was in consequence freed from organisms. The filters were then quickly added, the burner being raised sufficiently to admit of their insertion.

The results would seem to indicate that the temperature of the flasks was sufficient in most cases to destroy the vitality of the germs on the lower surfaces of the filters, as only three of the twelve infusions have as yet decomposed, while in the tubes only five out of the twelve have escaped infection. It is, however, possible that living germs have not as yet been detached from the filters in these cases. The dates of decomposition afford sufficient proof of the initial sterility of the infusions and the inoculation from the filters in the infected tubes, &c. Should the still undecomposed infusions of this series remain fresh for a long time, we shall try the effect of slight currents of air upon them. The results with these unsterilized filters show the necessity of careful sterilization of all filters.

Table II, first series—Wet filters.

The tubes and flasks were filled precisely as were those of Table I, and while the filters were still quite hot, distilled water, the sterility of which had been insured by protracted boiling, was added until the filters were completely saturated, the water being thrown upon them in a fine stream from a wash-bottle while still violently boiling. The filters in the tubes were kept saturated with water for a long time, a few drops of unsterilized water being subsequently added from time to time to supply the loss by evaporation. They were then allowed to partially dry, and have since been kept moist. Those in the flasks were allowed to gradually dry through evaporation.

While asbestus, coarse and fine sands, fine vegetable charcoal, and loess have, in the great majority of cases, protected the infusions, coarse animal charcoal of 15° (Nos. 11 and 12) failed, as it did in the dry state, to filter out the germs of the air.

Of the remaining seven cases of decomposition, two (Nos. 20 and 23) resulted from incomplete sterilization, one (No. 3) was undoubtedly, and two others (Nos. 1 and 4) were probably caused by subsequent infiltration of unsterilized water, too large a quantity having been incautiously added. This may possibly have been the case likewise with experiment No. 25, though no water was seen to have percolated the filter subsequent to the preparation of the experiment.

It was a matter of some difficulty to keep the filters thoroughly wet, and at the same time to prevent the water from running through into the infusions; and it will be observed that the decompositions resulting from infiltration of water were all with filters of sand, a material which signally fails, as is shown in experiments of the second series, to free liquids from their germs.

In No. 22 the decomposition is undoubtedly due to the final entrance of germs through the dry filter, as the infusion remained clear for 164 days, when a filamentous fungus appeared, which rapidly developed. In this experiment an ordinary, wide-necked flask was *very loosely* filled with asbestus to a height of about 2cm. After saturation with sterilized water the asbestus was allowed gradually to dry. This is, up to the present time, the only instance of infiltration through a short column of asbestus, as No. 151 of Table I is through sand.

FIRST SERIES OF EXPERIMENTS.

AIR-FILTRATIONS.

TABLE I.—*Dry Filters.*

No.	Infusion.	Dimensions of tubes, &c., employed.	Filters: Kind.	Filters: Length in centimeters.	Date of experiment.	Subsequent treatment.	No.	Date of decomposition.	Time in— Days.	Time in— Hours.
1	Beef	Tubes, 46 by 2cm, inner diameter. (See figure 1.)	**Asbestus (loosely packed.)**	14	June 9	No. 1, air sucked out several times June 21.	1	......	......	......
2				7			2	......	......	......
3			**Asbestus (tightly packed.)**	7			3	......	......	......
4			**Sand, 25° to 30°**	15	June 10	Air sucked out of Nos. 4 and 5 several times June 21.	4	......	......	......
5			**Sand, 100°**	14			5	......	......	......
6				8			6	......	......	......
7, 8, 9			*Open, for comparison.*	......	June 9	......	7, 8, 9	June 11	**Less than 2 days.**	
10	Beef	Flask, 750cm3	**Asbestus**	8	June 10	......	10	......	......	......
11	Beef	Flask, 750cm3	*Open*	......	June 10	......	11	June 12	**Within 3 days.**	
12*a*	Beef	Tubes, 46 by 2cm	**Sand, 25° to 30°**	15	June 9	No. 12, opened and exposed for 20 minutes June 17 and for 9 hours June 23.	12*a*	June 25	**About 2 days, 12 hours.**	
13*a*				5	June 9	No. 13, opened and exposed for 3½ hours June 21, and 24 hours June 25.	13*a*	June 26	**Less than 5 days from 1st exposure, within 1 from 2d.**	
14				8	June 9	No. 14, subsequently employed as a water-filter (see Table III, 2nd Ser., Water-filtrations).	14	See Table III.	......	......

FIRST SERIES OF EXPERIMENTS—Continued.

AIR-FILTRATIONS—Continued.

TABLE I.—*Dry Filters*—Continued.

No.	Infusion.	Dimensions of tubes, &c., employed.	Filters. Kind.	Filters. Length in centimeters.	Date of experiment.	Subsequent treatment.	No.	Date of decomposition.	Time in— Days.	Time in— Hours.
15 16	Beef	Tubes, 23 by 1cm	Asbestus plugs in the necks.	1	June 19	....	15 16	....	....	....
17 18	Beef	Tubes, 23 by 1cm	Sand, 25° to 40°	1 0.8	June 19	....	17 18	....	....	....
19 20b	Beef	Tubes, 23 by 1cm	Sand, 100°	1.5 b	June 19	....	19 20b	.... July 25	.... 36b	....
21 22	Beef	Test-tubes with rubber stoppers, containing tubes 5mm in diameter, plugged with asbestus.	Asbestus	1	June 19	....	21 22	....	....	....
23 24	Beef	Tubes, 46 by 2cm	*Open*		June 23	....	23 24	June 24 June 24	About 1 day, 12 hours.	
25 26c	Beef	Tube, 23 by 1cm Test-tube containing pieces of copper gauze.	*Open*		June 23	....	25 26c	June 30 June 24	7 1	....
27 28 29 30	Beef	No. 27, test-tube drawn out at the middle to a capillary tube 8cm in length. Nos. 28 and 29, test-tubes drawn out at the end to long capillary tubes. No. 30, test-tube drawn out to a capillary tube and bent over.	*Open*	....	June 28	....	27 28 29 30	July 2 July 12 July 2	4 14 4	....
31	Beef	Tubes, 23 by 1cm	*Open*	....	July 13	....	31	July 15	Less than 2 days.	
32 33 34	Beef	Tubes, 23 by 1cm	*Copper gauze in the necks.*	....	July 13	....	32 33 34	July 19 July 19 July 24	6 6 11	....
35 36 37	Beef (See note d.)	Flasks, of 250cm³	Asbestus, not ignited		July 27		35 36 37	....	....	....
38 39	Beef (See note d.)	Flasks, of 250cm³	Sand, 30° to 50° (unignited)	4	July 27	....	38 39	....	....	....
40	Beef (See note d.)	Flasks, of 250cm³	Sand, 25° to 30° (unignited)	4	July 27	....	40	....	....	....
41 42 43	Beef (See note d.)	Flasks, of 250cm³	* Absorbent cotton, unsterilized.	4	July 27		41 42 43	....	....	....
44 45 46	Beef (See note d.)	Flasks, of 250cm³	†Non-absorbent cotton, unsterilized.	4	Aug. 2	....	44 45 46	Sept. 7 Sept. 21 Sept. 9	36 50 38	....
47 48 49 50	Beef (See note d.)	Tubes, 23 by 1cm	Unignited asbestus	1	July 27		47 48 49 50	.... Aug. 1 Nov. 12	.... 35 108	....
51 52 53 54	Beef (See note d.)	Tubes, 23 by 1cm	Sand, 30° to 50°, unignited.	1 to 2	July 27	....	51 52 53 54	Aug. 10 July 30 Aug. 2 Nov. 18	44 33 36 114	....
55 56 57 58	Beef (See note d.)	Tubes, 23 by 1cm	Absorbent cotton, unsterilized.	1	July 27		55 56 57 58	Between Sept. 25 and Oct. 13.‡	60 to 78	 ....
59 60	Beef	Tubes, 23 by 1cm	Charcoal 25° to 30°	1.5	Aug. 3	....	59 60	....	....	....
61 62	Beef	Tubes, 23 by 1cm	Charcoal, 100°	1.5	Aug. 3	....	61 62	....	....	....
63 64 65 66 67 68	Beef	Tubes, 23 by 1cm	Animal charcoal, 15°	1 to 2	Aug. 28	....	63 64 65 66 67 68	Sept. 7 Sept. 18 Sept. 7 Oct. 13 Sept. 10 Sept. 7	10 21 10 Unknown, between 28 and 46 days. 13 10	....
69 70 71 72 73 74	Beef	Tubes, 23 by 1cm	Animal charcoal, 100°.	0.7 0.7 0.2 0.6 0.1 0.4	Oct. 19	....	69 70 71 72 73 74	....	....	....
75 76	Beef	Tubes, 23 by 1cm	*Open*	....	....	....	75 76	Oct. 24	5	....
77 78 79 80 81 82	Beef	Tubes, 23 by 1cm	Coal-ashes, 10° to 100°	0.8 2 1 1 1.2 0.7	Nov. 3	....	77 78 79 80 81 82	....	....	....
83	Beef	Tubes, 23 by 1cm	*Open*	....	Nov. 3		83	Nov. 5	2	....

may have gone on for some time before it became sufficiently marked to be detected, and the dates given in the tables would not then indicate even approximately the times of incipient decomposition. It certainly would not be impossible for this to happen, for the bacterial growths themselves could not be detected as in the transparent infusions of beef, hay, &c., through a cloudiness of the liquid, the formation of pellicles on its surface or a mere film on the glass at the edges of the infusion, but their presence could only be discovered through the precipitation of casein, in consequence of the lactic acid or butyric acid fermentation, &c., or through the formation of putrefaction products in large amounts.

It must, however, be observed that, after the first indications of souring or of putrefaction, the decompositions proceeded with marked rapidity, especially in No. 112.

Periodical microscopic examinations are evidently necessary in all filter experiments with milk in order to fully control the results, and in future tests we shall consequently so modify the apparatus as to admit of microscopical examinations without at the same time disturbing the filters. The necessity of microscopical examinations becomes more apparent from an examination of the experiments, Nos. 107 to 109 and 113 and 114.

The decompositions which have here taken place are more difficult still to account for. The milk in these flasks appeared to have remained unchanged for several months; small quantities of casein separated out very slowly, in somewhat granular masses, which remained for the greater part suspended. There were no indications of lactic acid fermentation or of putrefactive decomposition, nor could traces of vibrionic growths or of bacteria of decomposition be found under the microscope, with the aid of a Zeiss one-twelfth inch homogeneous oil-immersion objective, in Nos. 107 and 113, which were opened and examined January 22.

These had, however, an acid reaction, a peculiar, disagreeable, oily odor and taste, somewhat like that of stale, unsalted butter, and contained some spherical cells closely resembling colostrum-corpuscles, which were stained by anilin-violet. They had evidently undergone some chemical change. Exposed to the air they underwent the usual fermentation, the casein coagulating in thick curds.

Similar results were obtained from the examination of No. 114 in February (Hartnack, nine, water-immersion objective).

Nos. 108 and 109 gave the same oily odor, &c., but have not as yet been examined microscopically. With these we shall try cultivation tests.

These changes must have taken place either without the action of inferior organisms, *i. e.*, through strictly chemical processes, or else through the development of some form or forms of organisms in so inconsiderable a degree as to escape detection.

Besides the experiments just discussed, several tests (Nos. 35 to 58) were tried with unsterilized filters of sand, asbestus, and cotton for comparison with these, the object being to learn whether the germs which these bodies undoubtedly contain in consequence of their previous free exposure to the air would readily be detached from them and fall into the infusions in the tubes and flasks. For all germs deposited upon them from the air, after their insertion into the filter-tubes, they would act as filters as well as the sterilized materials, and only those germs adhering to the lower layers as the tubes were filled could become detached and fall into the infusions. A slight modification in the method of experimentation is here obviously necessary; for should the infusion be maintained at the boiling temperature during and subsequent to the addition of the filters, the germs adhering to their lower surfaces might be destroyed by the steam; while, on the other hand, should the infusions be allowed to cool, wholly or in part, previous to the insertion of the filters, there would be no guaranty that germs had not entered from the air.

In the series of flasks (Nos. 35 to 46) the filters were added directly the infusions ceased to boil after the removal of the flame. The series of tubes (Nos. 47 to 58) were partially cooled directly beneath the flame of a burner, so that the air on entering first passed through this, and was in consequence freed from organisms. The filters were then quickly added, the burner being raised sufficiently to admit of their insertion.

The results would seem to indicate that the temperature of the flasks was sufficient in most cases to destroy the vitality of the germs on the lower surfaces of the filters, as only three of the twelve infusions have as yet decomposed, while in the tubes only five out of the twelve have escaped infection. It is, however, possible that living germs have not as yet been detached from the filters in these cases. The dates of decomposition afford sufficient proof of the initial sterility of the infusions and the inoculation from the filters in the infected tubes, &c. Should the still undecomposed infusions of this series remain fresh for a long time, we shall try the effect of slight currents of air upon them. The results with these unsterilized filters show the necessity of careful sterilization of all filters.

Table II, first series—Wet filters.

The tubes and flasks were filled precisely as were those of Table I, and while the filters were still quite hot, distilled water, the sterility of which had been insured by protracted boiling, was added until the filters were completely saturated, the water being thrown upon them in a fine stream from a wash-bottle while still violently boiling. The filters in the tubes were kept saturated with water for a long time, a few drops of unsterilized water being subsequently added from time to time to supply the loss by evaporation. They were then allowed to partially dry, and have since been kept moist. Those in the flasks were allowed to gradually dry through evaporation.

While asbestus, coarse and fine sands, fine vegetable charcoal, and loess have, in the great majority of cases, protected the infusions, coarse animal charcoal of 15° (Nos. 11 and 12) failed, as it did in the dry state, to filter out the germs of the air.

Of the remaining seven cases of decomposition, two (Nos. 20 and 23) resulted from incomplete sterilization, one (No. 3) was undoubtedly, and two others (Nos. 1 and 4) were probably caused by subsequent infiltration of unsterilized water, too large a quantity having been incautiously added. This may possibly have been the case likewise with experiment No. 25, though no water was seen to have percolated the filter subsequent to the preparation of the experiment.

It was a matter of some difficulty to keep the filters thoroughly wet, and at the same time to prevent the water from running through into the infusions; and it will be observed that the decompositions resulting from infiltration of water were all with filters of sand, a material which signally fails, as is shown in experiments of the second series, to free liquids from their germs.

In No. 22 the decomposition is undoubtedly due to the final entrance of germs through the dry filter, as the infusion remained clear for 164 days, when a filamentous fungus appeared, which rapidly developed. In this experiment an ordinary, wide-necked flask was *very loosely* filled with asbestus to a height of about 2cm. After saturation with sterilized water the asbestus was allowed gradually to dry. This is, up to the present time, the only instance of infiltration through a short column of asbestus, as No. 151 of Table I is through sand.

FIRST SERIES OF EXPERIMENTS.

AIR-FILTRATIONS.

TABLE I.—*Dry Filters.*

No.	Infusion.	Dimensions of tubes, &c., employed.	Filters. Kind.	Filters. Length in centimeters.	Date of experiment.	Subsequent treatment.	No.	Date of decomposition.	Time in— Days.	Time in— Hours.
1	Beef	Tubes, 46 by 2cm, inner diameter. (See figure 1.)	**Asbestus (loosely packed.)**	14	June 9	No. 1, air sucked out several times June 21.	1	....	....	....
2				7			2	....	....	....
3			**Asbestus (tightly packed.)**	7			3	....	....	....
4			**Sand, 25° to 30°**	15	June 10	Air sucked out of Nos. 4 and 5 several times June 21.	4	....	....	....
5			**Sand, 100°**	14			5	....	....	....
6				8			6	....	....	....
7			*Open, for comparison.*	....	June 9	....	7	June 11	**Less than 2 days.**	
8							8			
9							9			
10	Beef	Flask, 750cm3	**Asbestus**	8	June 10	....	10	....	....	....
11	Beef	Flask, 750cm3	*Open*	....	June 10	....	11	June 12	**Within 3 days.**	
12a	Beef	Tubes, 46 by 2cm	**Sand, 25° to 30°**	15	June 9	No. 12, opened and exposed for 20 minutes June 17 and for 9 hours June 23.	12a	June 25	**About 2 days, 12 hours.**	
13a				5	June 9	No. 13, opened and exposed for 3½ hours June 21, and 24 hours June 25.	13a	June 26	**Less than 5 days from 1st exposure, within 1 from 2d.**	
14				8	June 9	No. 14, subsequently employed as a water-filter (see Table III, 2nd Ser., Water-filtrations).	14	See Table III.	....	....

FIRST SERIES OF EXPERIMENTS—Continued.

AIR-FILTRATIONS—Continued.

TABLE I.—*Dry Filters*—Continued.

No.	Infusion.	Dimensions of tubes, &c., employed.	Filters. Kind.	Filters. Length in centimeters.	Date of experiment.	Subsequent treatment.	No.	Date of decomposition.	Time in— Days.	Time in— Hours.
15 16	Beef	Tubes, 23 by 1cm	**Asbestus plugs in the necks.**	1	June 19		15 16			
17 18	Beef	Tubes, 23 by 1cm	**Sand, 25° to 40°.**	1 0.8	June 19		17 18			
19 20b	Beef	Tubes, 23 by 1cm	**Sand, 100°**	1.5 b	June 19		19 20b	 July 25	 36b	
21 22	Beef	Test-tubes with rubber stoppers, containing tubes 5mm in diameter, plugged with asbestus.	**Asbestus**	1	June 19		21 22			
23 24	Beef	Tubes, 46 by 2cm	*Open*		June 23		23 24	June 24 June 24	About 1 day, 12 hours.	
25 26c	Beef	Tube, 23 by 1cm Test-tube containing pieces of copper gauze.	*Open*		June 23		25 26c	June 30 June 24	7 1	
27 28 29 30	Beef	No. 27, test-tube drawn out at the middle to a capillary tube 8cm in length. Nos. 28 and 29, test-tubes drawn out at the end to long capillary tubes. No. 30, test-tube drawn out to a capillary tube and bent over.	*Open*		June 28		27 28 29 30	July 2 July 12 July 2 	4 14 4 	
31	Beef	Tubes, 23 by 1cm	*Open*		July 13		31	July 15	Less than 2 days.	
32 33 34	Beef	Tubes, 23 by 1cm	*Copper gauze in the necks.*		July 13		32 33 34	July 19 July 19 July 24	6 6 11	
35 36 37	Beef (See note d.)	Flasks, of 250cm³	**Asbestus, not ignited**	4	July 27		35 36 37			
38 39 40	Beef (See note d.)	Flasks, of 250cm³	**Sand, 30° to 50°** (38, 39) / **Sand, 25° to 30°** (40), **unignited**	4	July 27		38 39 40			
41 42 43	Beef (See note d.)	Flasks, of 250cm³	*** Absorbent cotton, unsterilized.**	4	July 27		41 42 43			
44 45 46	Beef (See note d.)	Flasks, of 250cm³	**† Non-absorbent cotton, unsterilized.**	4	Aug. 2		44 45 46	Sept. 7 Sept. 21 Sept. 9	36 50 38	
47 48 49 50	Beef (See note d.)	Tubes, 23 by 1cm	**Unignited asbestus**	1	July 27		47 48 49 50	 Aug. 1 Nov. 12	 35 108	
51 52 53 54	Beef (See note d.)	Tubes, 23 by 1cm	**Sand, 30° to 50°, unignited.**	1 to 2	July 27		51 52 53 54	Aug. 10 July 30 Aug. 2 Nov. 18	44 33 36 114	
55 56 57 58	Beef (See note d.)	Tubes, 23 by 1cm	**Absorbent cotton, unsterilized.**	1	July 27		55 56 57 58	Between Sept. 25 and Oct. 13. ‡	60 to 78	
59 60	Beef	Tubes, 23 by 1cm	**Charcoal 25° to 30°**	1.5	Aug. 3		59 60			
61 62	Beef	Tubes, 23 by 1cm	**Charcoal, 100°**	1.5	Aug. 3		61 62			
63 64 65 66 67 68	Beef	Tubes, 23 by 1cm	**Animal charcoal, 15°**	1 to 2	Aug. 28		63 64 65 66 67 68	Sept. 7 Sept. 18 Sept. 7 Oct. 13 Sept. 10 Sept. 7	10 21 10 Unknown, between 28 and 46 days. 13 10	
69 70 71 72 73 74	Beef	Tubes, 23 by 1cm	**Animal charcoal, 100°.**	0.7 0.7 0.2 0.6 0.1 0.4	Oct. 19		69 70 71 72 73 74			
75 76	Beef	Tubes, 23 by 1cm	*Open*				75 76	Oct. 24	5	
77 78 79 80 81 82	Beef	Tubes, 23 by 1cm	**Coal-ashes, 10° to 100°**	0.8 2 1 1 1.2 0.7	Nov. 3		77 78 79 80 81 82			
83	Beef	Tubes, 23 by 1cm	*Open*		Nov. 3		83	Nov. 5	2	

FIRST SERIES OF EXPERIMENTS—Continued.

AIR-FILTRATIONS—Continued.

TABLE I.—*Dry Filters*—Continued.

No.	Infusion.	Dimensions of tubes, &c., employed.	Filters. Kind.	Filters. Length in centimeters.	Date of experiment.	Subsequent treatment.	No.	Date of decomposition.	Time in— Days.	Time in— Hours.
84							84	Dec. 7	33	
85				3			85	Dec. 22	48	
86							86			
87							87	Jan. 5	62	
88	Beef	Tubes, 23 by 1^{cm}	Sand, 10° to 20°	6	Nov. 4		88			
89							89			
90							90			
91				9			91			
92							92			
93	Beef		*Open*		Nov. 4		93	Nov. 12	8	
94							94	Nov. 10	6	
95				1			95	Tube broken Nov. 5		
96				1			96			
97			Loess	1.3			97			
98	Beef	Tubes, 23 by 1^{cm}		1.5	Nov. 4		98			
99				1			99			
100				1			100			
101			*Copper gauze*				101	Nov. 20	16	
102							102	Nov. 11	7	
103*e*	Milk	Flask, 750^{cm^3}	Asbestus	8	June 11	Shaken occasionally	103*e*	July 2	21	
104	Milk	Flask, 750^{cm^3}	*Open*		June 11		104	June 12	1	6
105*f,i*	Milk	Flask, 1 L.	Asbestus	6	July 8	Shaken occasionally	105*f,i*	Sept. 6	60	
106*g*	Milk, unboiled	Flask, 1 L.	*Open*		July 8		106*g*	July 8	Within 10 hours.	
107			Sand, 30° to 50°	5			107*i*			
108							108*i*		Unknown.	
109	Milk	Flasks, 250^{cm^3}	Sand, 100°	5	July 10		109*i*			
110*h*	(See note *i*.)						110*h*	July 13	3	
111			*Copper gauze*				111	July 14	3	12
112			Asbestus (tightly packed.)	5	July 14	No. 112 shaken violently several times.	112*i*	Sept. 6	54	
113							113*i*		Unknown.	
114	Milk	Flasks, 250^{cm^3}				Nos. 107–110 and 112–114 occasionally shaken.	114*i*			
115	(See note *i*.)		*Copper gauze*				115	July 17	3	
116			*Open*		July 14		116	July 17	3	
117	Milk, unboiled	Flask, 250^{cm^3}	*Open*				117	July 15	Less than 24 hours.	
118	Hay	Flask, 100^{cm^3}	Asbestus	1	July 1		118			
119	Hay	Flask, 1 L.	Asbestus	1	July 1	No. 119 opened several times, and portions taken for the tubes in subsequent experiments; reboiled and asbestus plug reinserted.	119			
120			Asbestus	1			120			
121				0.8			121			
122	Hay	Tubes, 23 by 1^{cm}	Sand, 30° to 50°	0.6	July 1		122			
123				0.3			123			
124*j*			Sand, 100°	*j*			124*j*	July 29	28*j*	
125				0.4			125			
126	Hay	Tubes, 23 by 1^{cm}	*Open*		July 1		126	July 12	11	
127					July 13		127	July 19	6	
128					July 2		128	July 14	12	
129	Hay	Tubes, 23 by 1^{cm}	*Copper gauze*				129	July 25	12	
130					July 13		130	July 19	6	
131							131	July 19	6	
132		Test-tubes					132			
133							133			
134	Hay	Capsule	*Open*		June 31		134	July 1	Less than 24 hours.	
135		Flasks					135			
136							136			
137	Fish	Flask, 200^{cm^3}	Asbestus	5	July 15		137			
138			Asbestus	1.3			138			
139				1			139			
140			Sand 30° to 50°	0.2			140			
141				0.1			141			
142	Fish	Tubes, 23 by 1^{cm}	Sand 100°	0.5	July 15		142			
143				0.8			143			
144			*Open*				144	July 20	5	
145			*Copper gauze*				145	July 21	6	
146							146	July 29	14	
147	Cucumber	Flasks, 200^{cm^3}	Asbestus	5	July 22		147			
148							148			

FIRST SERIES OF EXPERIMENTS—Continued.

AIR-FILTRATIONS—Continued.

TABLE I.—*Dry Filters*—Continued.

No.	Infusion.	Dimensions of tubes, &c., employed.	Filters.		Date of experiment.	Subsequent treatment.	No.	Date of decomposition.	Time in—	
			Kind.	Length in centimeters.					Days.	Hours.
149	Cucumber	Tubes, 23 by 1^{cm}	Asbestus	0.8	July 22	....	149	....	....	....
150							150	....	....	....
151			Sand 30° to 50°	0.1			151	Dec. 15	146	....
152				0.2			152	....	....	....
153k			Sand 100°	k			153k	Nov. 24	125k	....
154k							154k	Oct. 18	88k	....
155			*Open*	....			155	July 23	1	9
156							156	July 24	2	....
157			*Copper gauze*	....			157	July 24	2	....
158							158	July 25	3	....
159	Cucumber	Flasks, 100^{cm^3}	*Open*	....	July 22	....	159	July 23	....	Less than 21
160			*Copper gauze*				160	July 23	....	
161	Beet	Flask, 200^{cm^3}	Asbestus	5	July 22	....	161	....	....	....
162	Beet	Tubes, 23 by 1^{cm}	Asbestus	1	July 22	....	162	....	....	....
163				1.4			163	....	....	....
164			Sand 30° to 50°	0.3			164	....	....	....
165							165	....	....	....
166			Sand 100°	0.7			166	....	....	....
167				0.3			167	....	....	....
168	Beet	Tubes, 23 by 1^{cm}	*Open*	....	July 22	....	168	July 25	3	....
169							169	July 27	Less than 5	....
170			*Copper gauze*	....			170	July 24	2	....
171							171	July 28	6	....
172	Beet	Flasks, 100^{cm^3}	*Open*	....	July 22	....	172	July 24	2	....
173			*Copper gauze*				173	July 24	2	....

* Surgeon's cotton.

† Cotton used for steamboat mattresses, &c.

‡ The tubes were not examined from the 26th of September to the 12th of October, inclusive.

a No. 12 was exposed for twenty minutes on the 17th instant without becoming infected, but decomposed in about two and one-half days after the exposure of nine hours on the 23d instant. No. 13 began to decompose within one day after the exposure of twenty-four hours on the 25th instant. The filters were freshly ignited before being replaced. In Nos. 12 to 14 the necks of the tubes were plugged with asbestus; in all the other tubes employed, disks of copper gauze, ordinarily of eighty meshes to the inch, were fitted into the necks, and were covered with a thin layer of sand, of 25° to 30°, whenever very fine filtering media were employed.

b In No. 20 the sand barely covered the copper gauze above the edges, and a small quantity *from the upper layers* gradually worked its way down behind the gauze into the infusion, carrying germs with it.

c No. 26. Pieces of copper gauze were added to the infusion to see whether the copper salts formed would affect the development of germs. (See Nos. 1 to 4, second series, Table I.)

d The filters in tubes 35 to 58, inclusive, were not heated or sterilized in any way.

e No. 103 showed the first indications of souring on the 2d instant; separation of case in took place very slowly.

f No. 105 was not boiled until noon, and had just begun to turn, showing slight acid reaction. It was boiled in a paraffin bath for over an hour, the temperature of the bath being about 110°. Coagulated rapidly, and subsequently putrefied.

g No. 106 was not boiled, and had soured completely by 3.30 p. m. Temperature 30° C.

h Putrefied.

i The flasks were boiled in a paraffin bath for a long time, at temperatures ranging from 101° to 110°. Nos. 107–109, and 113 and 114 remained for several months apparently unchanged. Casein separated in very small amounts in granular masses, which for the most part remained suspended in the milk. The separation proceeded so slowly that no date of incipient decomposition could be assigned. Nos. 107 and 113 opened on January 22 gave acid reaction and a peculiar odor resembling that of unsalted butter which has stood for a long time. Under the microscope (Zeiss, $\frac{1}{12}$ homogeneous oil-immersion), spherical cells, resembling colostrum-corpuscles, which are stained by anilin-violet were observed. No bacterial growths could be found in any portions. No. 105 contained the same spherical cells in addition to bacterial forms. Nos. 108 and 109 were not examined microscopically. No. 112, examined under the microscope (Hartnack, nine, water-im. objective), December 18, was found to contain living bacteria in great abundance. The casein separated out very rapidly after the first indications of souring. No. 114, as also Nos. 108 and 109, opened February 11, gave same oily odor, &c., as Nos. 107 and 113. No bacteria could be found in No. 114 (Hartnack nine, water-im. objective). Contained spherical cells similar to those in Nos. 107 and 113.

j Case similar to No. 20.

k Cases similar to Nos. 20 and 124.

NOTE.—A large number of infusions of beef, hay, fish, cucumber, and beet exposed in test-tubes, flasks, and capsules in different parts of the laboratory for comparison with these broke down within *thirty hours;* some within *twenty-four hours.* None remained clear over thirty hours.

Table IV, first series—Dry-filters. Quantitative, rapid air-filtrations.

Tubes, as shown in Fig. 3, were employed for these filtrations, and were filled in the same manner as those in Table I. The aspirations were in all cases through the same arm of the tubes, though both necessarily contained filters.

Three tubes of this series (Nos. 3, 8, and 14) were not completely sterilized when prepared, and two of them (Nos. 8 and 14) were consequently boiled again. In No. 1 bubbles were forced up into the filter, in consequence of the rapidity of a filtration, and decomposition ensued, as it almost invariably does in such cases, in consequence of direct infection down the tube. The tubes 1.3cm in diameter were found to be too narrow for the subsequent, more rapid filtrations, and only those 1.9cm in diameter were therefore tested. The filtrations with the narrow tubes are consequently not recorded in the table below.

Most of the wide tubes have been tested many times, *but in not a single instance as yet has the filter failed to remove the germs from the air passing through it, though the filtrations have finally been carried on with very great rapidity*, as will be seen by an examination of the tables.

We purpose to continue increasing the rate of these filtrations until the infusions finally break down, *i. e.*, until the air is forced through the filters in such a current that the germs are carried with it; though, in view of the surprising filtering powers of the materials employed, it may first be necessary to modify our apparatus.

FIRST SERIES OF EXPERIMENTS—Continued.

QUANTITATIVE AIR-FILTRATIONS—Continued.

TABLE IV.—*Rapid filtrations.*

[Filtrations of air, at intervals, beginning at rates of 1 *liter* in 3 to 7½ *hours*, and increasing to rates of 1 *liter* per 2½ to 1½ *minutes*.]

No.	Infusion.	Dimensions of tubes, &c., employed.	Filters. Kind.	Filters. Length in centimeters.	Date of experiment.	Subsequent treatment.	No.	Date of decomposition.	Time in— Days.	Time in— Hours.
1a	Beef	U-tubes, 32 by 1.3cm, inner diameter. (See Fig. 3.)	Asbestus	17	June 19	For dates and rates of filtration, see below.	1a	July 22	10 *from time of saturation.*	
2							2			
3b			Sand, 25° to 30°	11			3b	June 23	4b	
4				6			4			
5			Sand, 100°	11			5			
6				6			6			
7	Hay	U-tubes. Nos. 7, 9, and 11, 46 by 1.3cm, inner diameter; Nos. 8, 10, and 12, 32 by 1.9cm.	Asbestus (packed)	24	July 1	do	7			
8c				10			8c	July 7	6c	
9			Sand, 30° to 50°	24			9			
10				10			10			
11			Sand, 100°	28			11			
12				9			12			
13	Fish	U-tubes. Nos. 13, 15, and 17, 46 by 1.3cm; Nos. 14, 16, and 18, 32 by 1.9cm.	Asbestus (packed)	25	July 15	do	13			
14d				10			14d	July 19	4d	
15			Sand, 30° to 50°	25			15			
16				10			16			
17			Sand, 100°	25			17			
18				10			18			
19	Cucumber	U-tubes, 32 by 1.9cm	Asbestus (packed)	10	July 23	do	19			
20			Sand, 30° to 50°				20			
21			Sand, 100°				21			
22	Beet	U-tubes, 32 by 1.9cm	Asbestus (packed)	10	July 23	do	22			
23			Sand, 30° to 50°				23			
24			Sand, 100°				24			

DATES OF FILTRATION.*

No.	Infusion.	Rates of filtrations of two liters of air. July. 3 H.	3 M.	7 H.	7 M.	9 H.	9 M.	12 H.	12 M.	14 H.	14 M.	14 H.	14 M.	17 H.	17 M.	20 H.	20 M.	26 H.	26 M.	27 H.	27 M.	29 H.	29 M.	30 H.	30 M.	No.	Infusion.	Rates of filtrations of one liter of air. October. 25 H.	25 M.	26 H.	26 M.	November. 1 H.	1 M.	29 H.	29 M.
8	Hay	15	0															0	45					2	0	8	Hay	0 0	12 22			0	6	0	1½
10		12	0	8	0	4	0	2	0	1	40	1	15	1	15	0	55	0	38					0	30	10				0	4	0	3	0	1½
12		12	0	8	0	4	30	1	50	1	40	1	15	1	15	0	50	0	45					0	30	12				0	11	0	9½	0	2
14	Fish																			3	0			0	35	14	Fish	0	12			0	10	0	2½
16																8	30			2	30			2	0	16									
18																8	30			2	30			2	0	18									
19	Cucumber																					0	50			19	Cucumber	0	9			0	8	0	2
20																						0	45			20				0	9	0	4	0	1½
21																						0	45			21				0	9	0	3	0	2
22	Beet																					0	50			22	Beet	0	13			0	6	0	2
23																						0	50			23				0	10	0	5	0	1½
24																						0	50			24				0	9½	0	4	0	2

a The tubes were found to be too narrow for rapid filtrations, as the bubbles did not break readily. In No. 1, bubbles were carried up into the filter July 12, moistening it throughout with the infusion. The infusion decomposed at the surface, and decomposition spread downwards, infecting the infusion in the tube.

b Infusion probably not completely sterilized.

c No. 8 was probably not sterilized when filled. The infusion was boiled again in the tube July 17 to destroy the living organisms.

d No. 14 was not sterilized when filled, as it began to break down before being tested as a filter. The infusion was boiled again in the tube, July 21, to destroy the growths.

* The filtration of Nos. 1, 6, 7, 9, 11, 13, 15, 17 are omitted from this table, as *very* rapid filtrations could not be carried on in these narrow (1.3cm) tubes. The filtrations of *two* liters of air ranged from *fifteen hours* to *thirty-five minutes*. As the tubes would not admit of more rapid filtrations, the infusions being sucked up into the filters, subsequent filtrations of *one* liter of air were not attempted.

All of these experiments are to be tried with the remaining artificial filters—as spongy iron, carferal, &c.—which have not as yet been tested, and also with a large number and variety of natural soils and with still coarser sands and gravels; the quantitative filtrations, besides being continued with dry filters, are to be tried with sterilized wet filters, with unsterilized dry filters, and with filters moistened with unsterilized water, putrid infusions, &c.

The question of temperature is furthermore to be more fully taken into consideration, as this is perhaps a not unimportant factor in experiments of this nature, and some of the tests are to be made at temperatures of 35° to 50° or 60°, *i. e.*, at temperatures considerably above the average temperature of the air in summer.

SECOND SERIES OF EXPERIMENTS—LIQUID-FILTRATIONS.

Tables I and II—Filtrations of fresh and putrid infusions through sterilized filters.

For all of these experiments, excepting No. 5 of each table, tubes, as shown in Fig. 1, were employed. The tubes were strongly heated, filled with the hot sterilized filters, as before described, and then heated again in a Carius oven for several hours at a temperature of 250° to 275°, or, in a few cases, on a combustion-furnace at a low red heat. The flasks and filter-tubes used in experiment 5 of each table were very strongly heated over the naked flame of a large burner. After the tubes had cooled the infusions were slowly added. The fresh infusions were previously exposed to the air in capsules (see notes accompanying the tables) for a sufficient length of time to insure their containing germs.

As the filtrations into the tubes necessarily took place against the pressure of the air within the tubes, the air being forced out through the mass of the filters, they proceeded very slowly in most cases. As the object was, however, to determine whether the materials employed could, under the most favorable circumstances, act as filters, which at first seemed highly improbable, as the germs would naturally be expected to adhere somewhat tenaciously to the particles of a liquid, this was considered to be an advantage rather than an obstacle to the experiments. The simple devices resorted to in various cases to slightly hasten the filtrations, and to prevent the air from raising the mass of the filters, are described in the tables.

How very difficult it is to remove the germs from a flowing liquid, by means of a filter, is abundantly shown in the experiments of this series, many of the materials which afforded the infusions ample protection from the air failing here utterly to prevent the transmission of germs. Thus the sands, the vegetable charcoals, coarse animal charcoal, and likewise asbestus in most cases, did not in these tests act as filters for fresh beef infusions, and sand, vegetable charcoal, and coarse animal charcoal failed even to filter putrid beef infusions clear, the first few drops percolating them being almost invariably still cloudy from the bacterial growths, and continuing to decompose. The only exception to this is experiment No. 4, but only a drop or two of the infusion had filtered here.

On the other hand there are two (Nos. 13 and 14), and in all probability four (Nos. 12 to 14 and 30, Table I), cases of successful filtration of a fresh beef infusion through tightly-packed asbestus, which likewise removed both the products of germination and the undeveloped germs* themselves from a putrid beef and hay infusion in the only two cases (Nos. 6 and 12, Table II) in which it was tried.

Very fine animal charcoal (experiments 25–28, Table I) likewise served probably in every case to filter the infusions.* It is true that three of these filtered infusions subsequently decomposed, but the time required leaves no room for doubt that the cause was due to direct inoculation. The tubes were not sealed at the necks after the filtrations, as it seemed of interest to determine whether bacterial growths could spread through the fine charcoal filters, as they had previously done in a few instances in the first series of experiments through asbestus and sand filters, which had accidentally become permeated by the infusions, and, if so, to learn how long a time might be required for the infection to spread through the filters and down the films of liquid on the sides of the tubes into the filtered infusions. After the decompositions of Nos. 25, 26, and 28, which occurred in forty-five, forty-eight, and fifty-one days, respectively, No. 27 was, however, sealed. This has remained fresh.

In most of the cases of decomposition recorded in Table I the development of life was sufficiently rapid to be detected in from one to three days, and in a few cases even within a few hours after the filtrations. Several infusions (especially Nos. 3 and 4, 11 and 42), however, remained perfectly clear for a somewhat longer period. It is not impossible in these cases that the infusions were subsequently infected, as in the instances previously cited. It is, however, more probable that the fine sand and the asbestus acted here as differential filters, though failing to completely remove the germs.

It must here be remembered that the dates of decomposition given in these tables denote the times when the first appearance of an organic growth of any kind was observed, either through the appearance of a fungus in any part of the infusion, or, as was more frequently the case in these filtrations, through the detection of the first faint opalescent cloudiness of the liquid, so characteristic of some forms of bacterial developments, or, again, of a minute film on the tube around the edges of the infusion.

Whenever there could be any doubt in regard to the decomposition of the infusions recourse was had to the microscope, the examinations being made in most instances with a Zeiss, twelfth, homogeneous oil-immersion objective. A number of the infusions which had manifestly broken down were also examined microscopically, but as the object of our investigations was simply to determine in general whether the fungi and their germs were filtered out from the infusions, the microscopic examinations are not given in the tables. It is, however, perhaps worthy of note that while in all cases the ordinary bacteria of putrefaction (*B. termo*) and likewise *B. lineola* were present in decomposing infusions, *bacillæ* forms were very rarely met with, though the latter were almost invariably found in the water-filtrations of Table III; a fact which would appear to indicate a comparative freedom of the atmosphere in this locality from germs of this class.

That the filtered infusions should have decomposed somewhat more slowly than the corresponding unfiltered portions, which were left exposed for comparison and which were constantly receiving fresh accessions of germs from the surrounding atmosphere, is natural, and it is certainly possible that if the greater portion of the germs be removed by a filtration the decomposition may proceed so slowly as to require several days for its detection.

It is, however, clear from the experiments that only asbestus and fine animal charcoal of the filters as yet tried have the power of filtering these infusions. With these we shall try several more filtrations, sealing the tubes subsequent to the experiment.

* It may be argued that the evidence of perfect filtration in these two experiments is not conclusive so far as the undeveloped organisms are concerned, for, although the putrid infusions filtered clear, and have since remained perfectly limpid for seven months, yet there is a remote possibility that their nutritive matters for the forms of organisms which they contained may have become exhausted prior to the filtrations. Under such a contingency the filtered infusions may have retained germs, which, however, have subsequently not developed from simple lack of nourishment. We shall decide this by inoculation tests on other cultivating-liquids, as well as by determining whether the infusions are still capable of nourishing the same forms of organisms as before.

* As the filtrations were carried on in these experiments for three to four days, they are in reality tests both of fresh and putrid infusions.

SECOND SERIES OF EXPERIMENTS.

LIQUID-FILTRATIONS.

TABLE I.—*Filtrations of various fresh, unsterilized infusions through sterilized filters.*

No.	Infusion.	Dimensions of tubes, &c., employed.	Filters. Kind.	Filters. Length in centimeters.	Date of experiment.	Subsequent treatment.	No.	Date of decomposition.	Time in Days.	Time in Hours.
1 2	Beef .... (See notes *a*, *d*.)	Tubes, 46 by 2^{cm}	Sand, 25° to 40°	16	June 19	....	1 2	June 24	5	....
3 4			Sand, 100°				3 4	July 1	12	....
5*a*, *b*	Beef	Flask, 250$^{cm^3}$	Sand, 100°	45	June 23	....	5	June 24	1	....
6 7	Beef .... (See notes *a*, *c*.)	Tubes, 46 by 2^{cm}	Sand, 25° to 40°	15	June 26	....	6 7	June 27	1	....
8 9	Beef .... (See notes *a*, *c*, *d*.)	Tubes, 46 by 2^{cm}	Sand, 25° to 40°	15	June 28	....	8 9	June 30 June 29	2 1	....
10*c*	Beef	Tube, 46 by 2^{cm}	Asbestus (tightly packed).	15	July 9	No. 10 was warmed slightly on the 9th and 10th instants several times to hasten the filtration.	10	July 13	4	....
11 12	Beef .... (See note *c*.)	Tubes, 46 by 2^{cm}	Asbestus (tightly packed).	15	July 24	Tubes 11 and 12 were gently warmed several times, but the filtration was not carried on so rapidly as in the previous case.	11 12	Aug. 4 Aug. 29	11 36	....
13 14	Beef .... (See note *c*.)	Tubes, 46 by 2^{cm}	Asbestus (tightly packed).	15	July 31	Tubes 13 and 14 were sealed at the necks August 2.	13 14	....	Still fresh.	
15 16	Beef .... (See note *c*.)	Tubes, 46 by 2^{cm}	Charcoal, 30° to 100°	15	Aug. 4	....	15 16	Aug. 6 Aug. 8	2 4	....

SECOND SERIES OF EXPERIMENTS—Continued.

Liquid-Filtrations—Continued.

Table I.—*Filtrations of various fresh, unsterilized infusions through sterilized filters*—Continued.

No.	Infusion.	Dimensions of tubes, &c., employed.	Filters. Kind.	Filters. Length in centimeters.	Date of experiment.	Subsequent treatment.	No.	Date of decomposition.	Time in— Days.	Time in— Hours.
17	Beef .... (See note c.)	Tubes, 46 by 2^{cm}	Charcoal, 25° to 50°	15	Sept. 1	....	17	Sept. 3	2	....
18						....	18	Sept. 2	1	....
19						....	19	Sept. 2	1	....
20						....	20	Sept. 2	1	....
21			Animal charcoal, coarse and fine, mostly 15°.			....	21	Sept. 2	1	....
22						....	22	Sept. 3	2	....
23						Tubes 23 and 24 were sealed at the necks September 2.	23	Sept. 4	3	....
24							24	Sept. 4	3	....
25	Beef .... (See note a.)	Tubes, 46 by 2^{cm}.....	Animal charcoal, 100°.	15	Oct. 23	Tubes 25 to 28 were warmed several times to hasten the filtration. Tube 27 sealed at the neck December 15.	25	Dec. 7	45	....
26							26	Dec. 10	48	....
27							27	....	Still fresh.	
28							28	Dec. 13	51	....
29e	Milk...........	Tube, 46 by 2^{cm}........	Asbestus (packed) ...	15	July 8	....	29	July 13	5	....
30f	Hay .... (See note c.)	Tubes, 46 by 2^{cm}	Tightly Packed Asbestus.	15	July 1	....	30f	July 21 (?)	20 (?)	....
31f			Loosely Packed Asbestus.				31f	July 6	5 days possibly.	
32			Sand, 30° to 50°.....				32	July 1	....	8
33							33			
34	Fish .... (See note c.)	Tubes, 46 by 2^{cm}.....	Asbestus (packed) ...	15	July 10	Tubes 34 and 35 warmed to hasten the filtration.	34	July 12	1	10
35			Sand, 100°..........				35	July 11	1	....
36			Asbestus (packed) ...		July 14	....	36	July 15	1	12
37						....	37			
38g			Asbestus............			....	38	July 14	....	6
39	Cucumber ..... (See note c.)	Tubes, 46 by 2^{cm}.....	Asbestus (tightly packed).	15	July 22	Tubes 39 and 40 warmed very gently. Filtrations carried on very slowly.	39	July 28	6	....
40							40	July 25	3	....
41	Beet .... (See note c.)	Tubes, 46 by 2^{cm}.....	Asbestus (tightly packed).	15	July 22	Tubes 41 and 42 warmed very gently. Filtrations carried on very slowly.	41	July 29	7	....
42							42	Aug. 2	11	....

a The infusions were filtered very slowly into all the tubes, but especially into Nos. 1 to 4 and 6 to 9, from one to four days being allowed for the filtration of about two inches of the infusions. Only a very small quantity of the infusion filtered through the fine sands of Nos. 3 and 4, as the tubes were not warmed. As the air of the tubes could only escape by forcing its way up through the mass of the filters, some difficulty was experienced in carrying on the filtrations through the very fine sands and charcoals, the air tending to raise the entire mass of the filters instead of slowly working its way through them in minute bubbles. The charcoal filters were accordingly forcibly pressed down by disks of copper gauze, fitted tightly into the tubes. As the infusions in Nos. 1 to 4 were slightly colored by copper salts, due to action of the infusions upon the copper gauze employed, Ex. 26, 1st series, Table I was made to determine whether the copper salts present had any effect in preventing the decompositions. In no cases, however, as was subsequently found, have the copper salts preserved the infusions. The infusions for Nos. 1 to 5 were exposed for several hours in evaporating dishes to the air of a stable-loft; those for Nos. 25 to 28 were exposed over night in the laboratory, and were diluted with tap water before the filtrations.

b No. 5 contained a tube 50^{cm} by 1.5^{cm}. Tube tightly packed with asbestus in the neck of the flask. The filtration was carried on rapidly.

c The infusions Nos. 6 and 7 were exposed for six hours in evaporating dishes near old hay in a cellar. Those for Nos. 8 and 9 were exposed nine hours near old hay. Those for Nos. 10 to 24 and Nos. 30 to 38 were exposed in the laboratory over night in evaporating dishes. Those for Nos. 39 to 42 from 9 a. m. until 6 p. m. on the 22d instant in capsules.

d Tubes 8 and 9 were heated on a combustion-furnace at a red heat nearly one hour. Tubes 1 to 4 were heated on a combustion-furnace ten minutes at as high a temperature as the glass would bear without softening.

e Filtered liquid was very thin and watery, the filter removing the greater portion of the fat and casein; evolved gas, and, upon being shaken, coagulated rapidly.

f No. 31 was clear on the 3d instant, and was not examined again until the 6th instant. No. 30 showed a very faint cloudiness on the 21st instant, but the traces of bacterial development were so very faint as to leave it doubtful for some time whether decomposition had actually set in or not.

g In No. 38 the infusion was not filtered, the tube being packed with asbestus after it was filled with the infusion, the object being to determine whether the presence of the asbestus column retarded the initiation of decomposition, affected its rate, &c.

SECOND SERIES OF EXPERIMENTS—Continued.

Liquid-Filtrations—Continued.

Table II.—*Filtrations of putrid infusions through sterilized filters.*

No.	Infusion.	Dimensions of tubes, &c., employed.	Filters. Kind.	Filters. Length in centimeters.	Date of experiment.	Subsequent treatment.	No.	Date of decomposition.	Time in— Days.	Time in— Hours.
1	Beef .... (See note a.)	Tubes, 46 by 2^{cm}.....	Sand, 25° to 40°...	16	June 19	....	1a	(See note a.)	0	0
2				17			2a			
3			Sand, 100°.........	16		....	3a			
4				17			4	July 7	19	....
5b	Beef	Flask, 250^{cm3}..........	Sand, 100°............	45	June 23	....	5b	(See note b.)	0	0
6	Beef	Tube, 46 by 2^{cm}........	Asbestus (tightly packed).	15	July 3	In Nos. 6 and 12 the infusions were filtered as completely as possible, and the tubes were dried just below the neck at a gentle heat to prevent subsequent infection of the filtered infusions by direct growths down the filters and sides of the tubes.	6	....	Still fresh.	
7c	Beef	Open tube, 60 by 1.3^{cm}.	Asbestus (tightly packed).	50	July 12		7c	(See note c.)	0	1
8	Beef .... (See note d.)	Tubes, 46 by 2^{cm}.....	Charcoal, 25° to 50°..	15	Sept. 1		8d	(See note d.)	0	
9							9d			
10			Animal charcoal, coarse and fine, 15° mostly.				10d			
11							11d			
12	Hay	Tube, 46 by 2^{cm}........	Asbestus (tightly packed).	15	July 3		12	....	Still fresh	

a Nos. 1, 2 and 3 could not be filtered clear and continued to decompose. Only a few drops passed No. 4, which remained clear until the 7th of July. The tubes were heated on a combustion-furnace for ten to fifteen minutes at as high a temperature as the glass would bear without softening.

b No. 5 could not be filtered clear. Apparatus arranged as in No. 5, Table I.

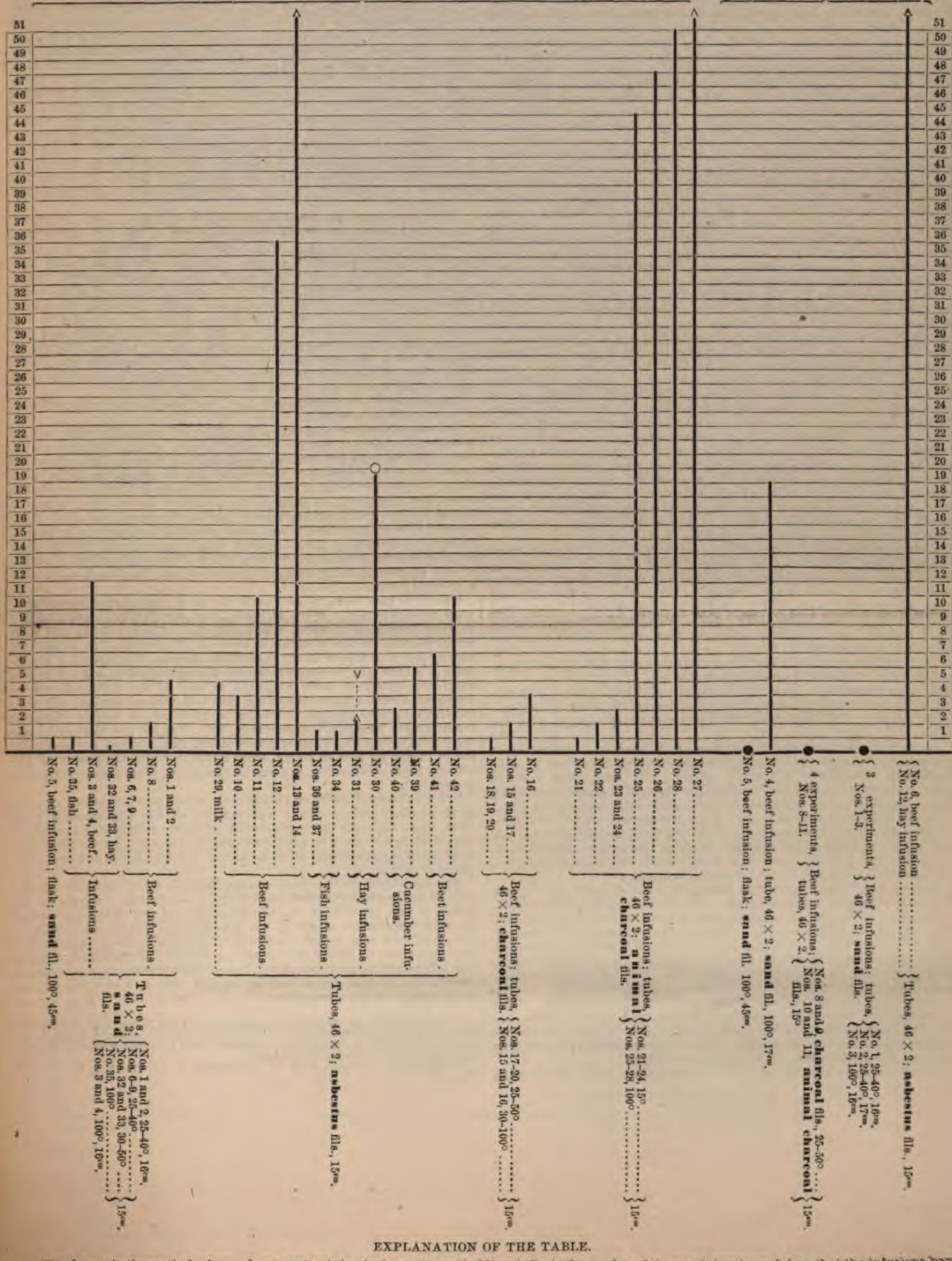
c A very putrid infusion was filtered through No. 7 to see whether the bacteria, odor, &c., could be removed by employing a longer filtering column. The first 100^{cm3} which passed the filter were clear and almost entirely devoid of odor. On standing exposed to the air decomposition set in again within sixteen hours. Subsequent portions filtered cloudy and retained more or less the putrid odor.

d Filtered cloudy and continued to decompose.

Beef infusions, which were muddy from bacterial developments, were employed, and a hay infusion for No. 12, which had stood for several days exposed in a capsule. *A portion of No. 5 was taken for No. 6.*

Graphical Table I.

FILTRATIONS OF FRESH INFUSIONS. FILTRATIONS OF PUTRID INFUSIONS.



EXPLANATION OF THE TABLE.

The figures in the vertical columns denote *units of time in days*; the vertical lines indicate the number of days and fractions of days that the infusions have remained fresh. The lines running entirely through the scale and terminating in arrow-heads represent still undecomposed infusions. Dotted lines in continuation of the vertical lines are used where the decompositions could only be told within certain limits. Putrid infusions which could not be filtered clear are marked with a single dot. [A c]ircle in termination of a straight *line denotes that* the time of decomposition was not definitely determined. The figures 46 × 2 denote in centimeters the dimensions [of the] tubes. *The numbers refer to the Nos. in Tables I and II* of second series. The figures marked ° express the number of meshes to the inch of the sieves through [which the] *filters are screened, and denote the degrees of fineness of the filters.* The figures marked cm denote the lengths of the filter columns in centimeters.

Table III, second series—Water-filtrations.

The experiments with a few exceptions, which are specially described below, were prepared precisely as were those recorded in Table I, first series, and were allowed to stand a sufficient length of time, usually from three to five weeks, to prove their sterility. Water was then added, which slowly percolated the filters and ran into the infusions. In most of the experiments the filtrations were carried on very gradually, and very small quantities only of water were allowed to pass the filters. The filtrations through the asbestus, coal-ash, and fine animal charcoal columns were, however, finally conducted much more rapidly, the tubes being occasionally gently warmed above the infusions to expel the air and hasten the flow of the liquid.

The fine animal charcoal filters, as also some of the clay filters, were forcibly maintained in position in the tubes by disks of copper gauze. The loess, coal-ash, and many of the clay filters were furnished with ventilating tubes (5mm in diameter), which extended through the mass of the filters to the sieves on which they rested, and projected for an inch or two above the tubes. These ventilating tubes were plugged at both ends with asbestus to prevent the entrance of unfiltered air; were heated for several hours in a Carius oven at a temperature of 250°, and were immediately transferred while at this temperature to the filter-tubes, as the latter were taken from the paraffin bath. The hot filters were then packed around them as quickly as possible, the filter tubes, as before, being very strongly heated. But very little advantage was, however, derived from the use of these tubes, the method of employing copper disks to keep the filters in place, and gently warming the tubes to expel the air, being on the whole preferable.

As will be seen by a study of the table only one of the filters has served to wholly protect the infusions from infection. Tightly packed asbestus, fine animal charcoal, and, perhaps, coal-ashes also have filtered the water to some extent; the first portions passing the filters being probably entirely freed, and the final portions, which were rapidly filtered, being almost entirely freed from germs, as the decompositions have taken place with extreme slowness, and, in some of the experiments with asbestus filters especially, are still so faintly marked as scarcely to be detected. It is possible that the loess also may have acted to a very slight degree as a differential filter, inasmuch as a considerable quantity of water was filtered into these tubes before the infection could be discerned.

Sands, pure clay, mixtures of sand with clay in different proportions, vegetable charcoal, and coarse animal charcoal, were, on the other hand, in these short columns, entirely devoid of any filtering power for water, as they were before, so far as tried, for the infusions themselves. Only very trifling amounts of water passed these filters before the infusions broke down; and the decompositions proceeded very rapidly, the infusions becoming thoroughly turbid in a few days, while masses of the *debris* collected at the bottoms of the tubes. Nos. 32 and 40 remained clear for some time, but scarcely an appreciable amount of water passed these filters.

A large number of these infusions, especially those in which the growths were feebly marked, were at different times examined microscopically. The results of these examinations are given in the table.

In view of the extreme importance considered with reference to the sanitary aspects which experiments on germ filtrations by soils possess, it was deemed advisable not only to extend these tests to other natural soils, but also to continue them with sands, employing much longer filtering columns, in order more fully to test the question whether they possess in any degree the power to act as filters. Tests with other soils have not as yet been tried to any great extent, but we are enabled in this report, through the experiments Nos. 2, 56, and 57, to give decisive and complete results in answer to the question so far as sand filtrations are concerned.

In experiment No. 2, a filtering column of the finest sand, a little over four feet in length, was employed. The glass filter-tube was heated, then filled with very hot sand, and heated again very intensely throughout its entire length. After cooling sufficiently it was attached to the flask containing the infusion, which was then boiled for over an hour to insure its absolute sterility. The rubber stopper through which the filter-tube passed was provided with a second, short tube filled with asbestus, which furnished an escape for the steam during the boiling and for the air during the filtration. This asbestus tube, as were those used in all subsequent experiments, was carefully sterilized. Freshly ignited asbestus was packed into the heated tubes, and the usual precautions were observed to thoroughly heat all the utensils employed in the operations.

In experiments Nos. 56 and 57 lead pipes were used, the filtering columns of mixed coarse and fine sand (18° to 100°) being 22 and 100 feet in length, respectively. (Fig. 4 shows the arrangement of the apparatus.)

The sand was heated in a large boiler for a long time, the boiler being maintained at a full red-heat, and was then poured into the pipes while still intensely hot. The latter, closed at the lower ends, were suspended perpendicularly during this process, and the sand was filled in as compactly as possible. The longer pipe was filled in two lengths, which were afterwards soldered together. The pipes were then coiled, disks of copper gauze were fitted into the lower ends to prevent the sands from falling into the flasks, and short tubes of quarter-inch pipe soldered on to them to connect with the flasks.

Although the heat of the sand was deemed amply sufficient to thoroughly sterilize the inner walls of the lead pipes, yet to leave no room whatsoever for doubt in regard to the sterility of the filters, the coils before being attached to the flasks were heated for some six hours at a temperature of over 250° in an air-bath * constructed for this purpose.

After attaching the coils to the flasks the infusions were, as usual, boiled for over an hour. In experiment No. 56 the apparatus was allowed to stand for a week; in experiment No. 57 for nearly a month, before the filtrations were started. The percolation of No. 56 was effected in one day, while that of the longer tube required fifteen days; the filter was not, however, constantly supplied with water during the nights, and no attempts were made to hasten the filtration. The amounts of water added each day are recorded in the table. The pipe was coiled in several concentric helices, and the water in traversing its entire length was forced to pass alternately up and down the successive coils. The most favorable conditions were thus afforded for the filtration of the water, in case the sand exerted any power whatsoever of removing the germs.

These tests show conclusively the utter worthlessness of sand as a filter for germinal matter.

The investigation into the absorption of inorganic salts and of nitrogenous organic matter by sand filters, which we hope at an early date to take up, derives an additional interest from these results. In view of the fact that sands fail to retain in their pores these particulate forms of matter it would appear highly improbable that they can exert, at least to any marked degree, an absorptive action on the still finer matters, organic or inorganic, of a solution. Should this prove to be the case, and should it furthermore be found, as the researches of Boussingault† would appear to indicate, that organic matter is oxidized with extreme slowness in a bed of sand, it will be seen that no reliance whatsoever can be placed upon it as a natural filter.

The facts here brought out seem to us of importance considered with reference to the sources of supply of our drinking waters; the relative locations of wells, cess-pools, &c., in our towns; and also with reference to the methods of removal of excreta, &c., especially during the prevalence of an infectious disease, the infective materials of which may be communicated through water. A good bed of sand has commonly been regarded as one of the most efficacious forms of filters, amply protecting our well-waters against all contamination, even though the wells be sunk at no remote distance from sewers, cess-pools, cemeteries, &c. But we see that sand utterly fails to remove germs of putrefaction, &c., such as are normally found in the air and in water, from liquids; while its power of absorbing dissolved matter, organic or inorganic, must also be seriously questioned.

Nor do the sandy or even clayey soils afford us a safeguard against germ contamination of our well-waters, as the experiments with loess, clay, and clay mixtures would probably justify us in concluding, although it must be admitted that we have not here strictly the same physical conditions as in a natural soil which has not been subjected to heat.

The subject of germ transmissions through soils demands on the part of sanitarians the most searching investigation, not only on account of the possibility of contamination of our drinking waters through infiltration of germs, but also because the air, especially in our dwellings, may become infected if the soils in their natural conditions possess no power of retaining germs or their adult organisms. For whenever in an infected soil the ground-water, from any cause, rises to the surface, germs may be carried with it and upon drying be taken up by the atmosphere.

* It consisted of a galvanized-iron cylinder some 3 feet in length by 18 inches in diameter, with cross bar supports for the coil to rest upon, about a foot from the bottom, with slides to regulate the temperature, and apertures at the top and just below the coil supports for thermometers.

† Boussingault. Comptes rend. 76; Jahresber. f. Ag. Ch. 1875-76; XVIII-XIX 42.

SECOND SERIES OF EXPERIMENTS—Continued.

LIQUID-FILTRATIONS—Continued.

TABLE III.—*Filtrations of water into sterilized infusions.*

No.	Infusion.	Dimensions of tubes, &c., employed.	Filters. Kind.	Filters. Length in centimeters.	Date of experiment.	Subsequent treatment.	No.	Date of decomposition.	Time in— Days.	Time in— Hours.
1*a*, *c*	Beef	Tube, 46 by 2cm	Sand, 25° to 30°. Asbestus plug in neck of the tube.	8	Filled June 9	A few drops of water filtered through July 9.	1*a*, *c*	July 11	2	
2*b*	Beef	Tube, 150cm by 1.25cm, and flask, 1 liter.	Sand, 100°	125	July 24	Filtration of water on the 26th instant.	2*b*	July 28	2	
3*c*	Beef	Flask, 250cm³	Sand, 30° to 50°	5	July 27	Water added in just sufficient quantity to saturate the sand but not to filter through, August 3 and again August 13.	3*c*	Aug. 16	13?	
4 5 6 7	Beef (See note *c*.)	Tubes, 46 by 2cm	Sand, 30° to 50°	15	July 13	Water added to Nos. 4 to 7 on August 13, 14, 15, and 16. A few drops filtered through No. 4 on the 16th instant, through Nos. 5 to 7 on the 19th instant.	4*c* 5*c* 6*c* 7*c*	Aug. 17 Aug. 19 Aug. 19 Aug. 19	Less than 15 hours. Within 2 or 3 hours. Within 10 hours.	
8 9 10 11 12 13	Beef (See note *d*.) Cucumber (See note *d*.) Beet (See note *d*.)	Tubes, 46 by 2cm	Asbestus (tightly packed.)	15	July 23	Filtrations of water into the infusions on August 24, 26, 28, 30, 31, September 1 and 2.	8*d* 9*d* 10*d* 11*d* 12*d* 13*d*	Sept. 7*d* Unk'n*d*	14 Unknown.	
14 15	Beef (See note *e*.)	Tubes, 46 by 2cm	Charcoal, 100°	15 7	Aug. 3	Additions of water October 15, 16, 17, and 18. A few drops of water percolated No. 15 on the 18th, and No. 14 on the 19th instant.	14*e* 15*e*	Oct. 26 Oct. 22	7 4	
16 17 18	Beef (See note *c*.)	Tubes, 46 by 2cm	Animal charcoal, coarse and fine, mostly 15°.	15	Aug. 28	Additions of water on October 15 and 16. A few drops filtered through on the 16th instant.	16*c* 17*c* 18*c*	Oct. 18	1	12
19 20 21 22	Beef (See note *f*.)	Tubes, 46 by 2cm	Animal charcoal, 100°	15	Oct. 19	Filtrations of water into Nos. 20 to 22 November 24, and into No. 19 November 27. Filtrations continued rapidly into Nos. 19 and 21 December 1, and into Nos. 19, 21, and 22 December 2, 3, 10, and 13, when the tubes were completely filled. Filtrations into No. 20 continued December 13, and carried on slowly.	19*f* 20*f* 21*f* 22*f*	Dec. 14 Dec. 15 Dec. 14	17 Still fresh. 21 20	
23 24 25	Beef (See note *g*.)	Tubes, 46 by 2cm	Charcoal, 25° to 50°	15	Oct. 19	Filtrations of water Nov. 23.	23*g* 24*g* 25*g*	Nov. 28	4	12
26 27 28 29 30 31	Beef (See note *h*.)	Tubes, 46 by 2cm	Mixture of sand, 18° to 100°, 3 parts, and pure kaolin 1 part, by weight.	15	Sept. 24	Additions of water to 26 to 28 on October 15 and 16. A few drops filtered through on the 16th instant. Filtrations of 26 and 27 continued on the 19th instant, as the infusions were still clear. Filtrations of 29 to 31 begun October 18 and continued until the 22d instant, when a small quantity was filtered through. Further filtration of 29 on the morning of the 25th instant, as the infusion remained clear.	26*h* 27*h* 28*h* 29*h* 30*h* 31*h*	Oct. 22 Oct. 20 Oct. 19 Oct. 25 Oct. 23 Oct. 23	6 4 3 3 1 1	 3 12
32*i* 33 34 35 36 37	Beef (See note *h*.)	Tubes, 46 by 2cm	Mixture of sand, 18° to 100°, 1 part; kaolin, 1 part.	15	Nov. 3	Filtration of water into Nos. 33 and 35 November 23, and into Nos. 32, 34, 36, and 37 November 24. The filter columns were kept saturated, and the filtrations proceeded very slowly from day to day.	32*i*, *h* 33*h* 34*h* 35*h* 36*h* 37*h*	Dec. 14 Dec. 1 Dec. 2 Nov. 27	20 8 8 4 3	
38 39 40*i* 41 42 43	Beef (See note *h*.)	Tubes, 46 by 2cm	Kaolin	15	Nov. 3	Filtrations of water into Nos. 38 to 41 and 43 November 24, and into No. 42 November 27. Filtrations continued very slowly from day to day.	38*h* 39*h* 40*i*, *h* 41*h* 42*h* 43*h*	Nov. 29 Nov. 30 Dec. 13 Nov. 28 Nov. 30 Nov. 28	5 6 19 4 3 4	
44 45 46 47 48 49	Beef (See note *j*.)	Tubes, 46 by 2cm	Coal-ashes, 10° to 100°	15	Nov. 3	Filtrations of water begun November 23 and continued from day to day until decomposition ensued. Filtrations carried on rapidly December 2 and 3, the tubes being nearly filled. No. 49 was completely filled December 10.	44*j* 45*j* 46*j* 47*j* 48*j* 49*j*	Dec. 4 Dec. 4 Dec. 7 Dec. 3 Dec. 9 Dec. 12	11 11 14 10 16 19	
50 51 52 53 54 55	Beef (See note *h*.)	Tubes, 46 by 2cm	Loess, 100°	15	Nov. 4	Filtrations of water begun November 23 and continued slowly from day to day until the infusions decomposed.	50*h* 51*h* 52*h* 53*h* 54*h* 55*h*	Nov. 30 Nov. 29 Dec. 1 Nov. 29	7 6 8 6	

SECOND SERIES OF EXPERIMENTS—Continued.

LIQUID-FILTRATIONS—Continued.

TABLE III.—*Filtrations of water into sterilized infusions*—Continued.

No.	Infusion.	Dimensions of tubes, &c., employed.	Filters. Kind.	Filters. Length in centimeters.	Date of experiment.	Subsequent treatment.	No.	Date of decomposition.	Time in— Days.	Time in— Hours.
56	Beef	Lead pipe, 23 feet by 1 inch, and flask, 1 liter. (See figure 4.)	Sand, 18° to 100°	22 feet	Sept. 6	Filtration September 13, 1,500$^{cm^3}$ of water being added.	56*k*	Sept. 15	2	....
57	Beef	Lead pipe, 101 feet by 1 inch, and flask, 1 liter. (See figure 4.)	Sand, 18° to 100°	100 feet	Sept. 24	Additions of water (well water containing fungoid growths, &c.): 1,000$^{cm^3}$, October 18. 700$^{cm^3}$, October 19. 300$^{cm^3}$, October 20. 400$^{cm^3}$, October 21. 400$^{cm^3}$, October 22. 400$^{cm^3}$, October 23. 300$^{cm^3}$, October 24. 300$^{cm^3}$, October 25. 260$^{cm^3}$, October 26. 260$^{cm^3}$, October 27. 260$^{cm^3}$, October 28. 260$^{cm^3}$, October 29. 280$^{cm^3}$, October 30. 280$^{cm^3}$, October 31. 240$^{cm^3}$, November 1. 5,600$^{cm^3}$ Some 100$^{cm^3}$ filtered into the infusion by midnight of November 1.	57*k*	Nov. 3	Nearly 2	....

a See No. 14, First Series, Table I.

b In No. 2 the open tube was fitted air-tight into the flask by means of a rubber stopper. The stopper was provided with a second tube plugged with asbestus for steam-escape during ebullition, and air-escape during filtration. The bacterial developments were very rapid and profuse.

c Bacterial growths very abundant.

d Tubes 8 to 13 were filled with water September 2. September 7 Nos. 8, 9, 10, and 11 showed *very faint* traces of bacterial growths. These growths have increased but very little since the 7th of September. The dates for Nos. 12 and 13 could not be determined, so faint were the signs of growths. The tubes were apparently perfectly clear for a month, and on December 18 No. 13 still showed only a *very slight* opalescence. Microscopical examination of No. 13 December 18 revealed but the merest traces of bacterial growths. Microscopical examinations of Nos. 8 and 9 December 23 revealed very feeble bacterial growths (*B. termo*, &c).

e Bacterial growths distinct in No. 14 and abundant in No. 15. (Ordinary bacteria of putrefaction, *B. termo*, and also *B. lineola*.)

f The filtrations were carried on very rapidly in Nos. 19, 21, 22; bacterial development in No. 19 very slow. Examined under the microscope December 23. Bacterial growths in Nos. 21 and 22 distinct, but not abundant. Microscopical examination January 26 (*B. termo; Micrococci; Bacillae—Bacillus-ulna? ; Spirilla—Spirillum-undula*).

g Bacterial growths very rapid.

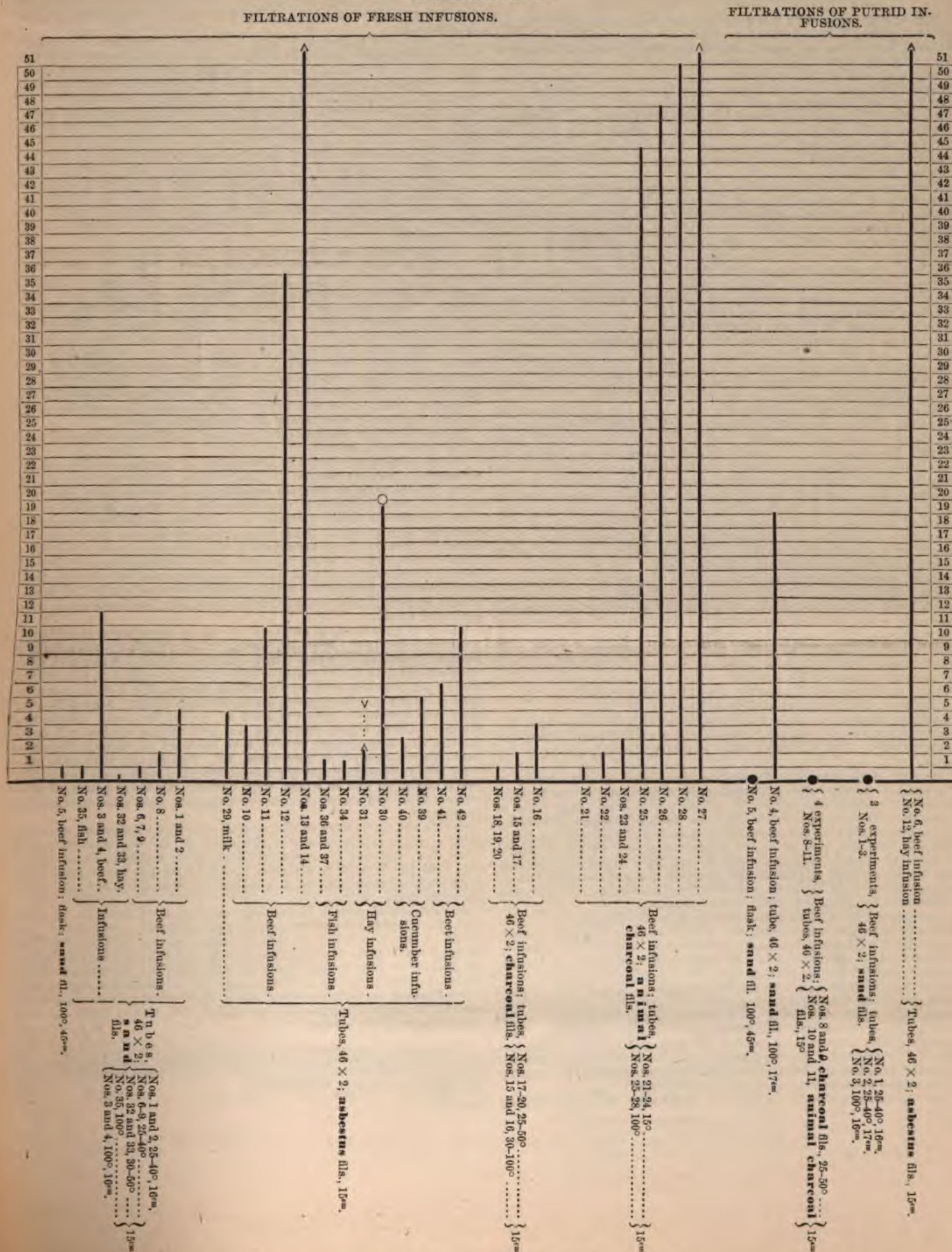
h Decomposition rapid. Microscopical examinations of several of these infusions showed presence of *B. termo* and *Bacillæ*.

i A few drops of water filtered through on November 24. Subsequently, scarcely an appreciable amount passed the filters.

j Bacterial growths slow, but finally profuse.

k In No. 56 the lead pipe was connected with the flask by a lead tube, 6 by ½ inches, which was soldered to the pipe and passed air-tight through the rubber stopper of the flask. In No. 57 the lead tube did not enter the flask directly, but was connected with a glass tube of same diameter, which passed through the rubber stopper, by rubber tubing to which a pinch-cock was attached to control the flow of water into the infusion. The bacterial growths were very rapid and abundant in both flasks.

GRAPHICAL TABLE I.



EXPLANATION OF THE TABLE.

The figures in the vertical columns denote *units of time in days*; the vertical lines indicate the number of *days and fractions* of days that the infusions have re-
...h. The lines running entirely through the scale and terminating in arrow-heads represent still undecomposed infusions. Dotted lines in continuation of the
... are used where the decompositions could only be told within certain limits. Putrid infusions which could not be filtered clear are marked with a single dot.
...mination of a straight line denotes that the time of decomposition was not definitely determined. The figures 46 × 2 denote in centimeters the dimensions
The numbers refer to the Nos. in Tables *I* and *II* of second series. The figures marked ° express the number of meshes to the inch of the sieves through
are screened, and *denote the degrees of fineness of the filters*. The figures marked cm denote the lengths of the filter columns in centimeters.

THIRD SERIES OF EXPERIMENTS—TRANSMISSION OF GERMS FROM A LIQUID TO THE AIR.

The question whether germs could be taken up by the atmosphere from a wet soil or a putrescent liquid was one which early engaged our attention. It has of late years been affirmed by many writers that germs are freely given off to the surrounding air through the evaporation of a liquid. The researches of Naegeli,* and the still more recent investigations of Carmichael,† Wernich,‡ Miquel,§ and others, published during the present year in various scientific journals, have, however, conclusively proved the falsity of this view, their experiments clearly showing that, under normal conditions of temperature at least, germs are never given off from a liquid at rest or from a thoroughly moistened sand or solid matter of any kind. Although we became acquainted with the results of these researches during the progress of our own investigation, nevertheless it seemed desirable to continue the experiments in view of the many important sanitary interests involved.

In our study of the deportment of liquids, with reference to their germinal matters, three questions were considered, viz:

1. *Can a liquid give off germs to the superincumbent atmosphere when both are in a state of rest?*

2. *Can a current of air take up germs from a liquid at rest?*

3. *Can a liquid part with germs when bubbling, in consequence of the evolution of gases produced by its own fermentation, &c., or of the aspiration of air through its mass?*

To test the first question (experiments 1 to 6) the form of apparatus shown in Fig. 5 was employed. It consists essentially of a wide-necked flask for the sterilized infusion (*d*), into which a moderately wide tube, bent near the lower extremity so as to form a trap for the sewage, putrid infusion, &c. (*f*), is inserted. The longer arm of this tube passes air-tight through a rubber stopper in the neck of the flask and communicates freely with the outer air. The stopper contains in addition an asbestus filter-tube (*e*).

The infusions were boiled as usual for a long time to insure the sterility of the flasks and entire contents, the rubber stoppers being tightly inserted and the bends of the trap-tubes being filled with a little distilled water. While the flasks were cooling, these tubes were tightly stoppered to prevent the entrance of unfiltered air. The tube-stoppers were then removed and the decomposing liquids cautiously added, by means of a pipette, until they filled the tubes to within about half an inch from the tops of the shorter arms. The apparatuses were then allowed to stand at rest.

In the experiments (Nos. 7–9) on the second question U-tubes were employed as traps, which were connected with the flasks by narrow tubing, as seen in Fig. 6. Both the flasks and the traps contained asbestus tubes. In preparing the experiments the flasks and U-tubes detached were boiled for a long time, the bends of the latter being filled with distilled water. They were then connected by rubber tubing and the boiling continued for some time, the connecting tube (*c*) being raised a little above the surface of the infusion in the flask. The portions of the connecting tubes above the flasks were at the same time strongly heated in order to absolutely insure the destruction of all germs in them, and the asbestus tubes were likewise warmed to prevent the condensation of steam. The open arms of the U-tubes were, as before, stoppered while the apparatuses were cooling, in order that only filtered air might enter the flasks. The U-tubes were then nearly filled with the decomposing liquids, the small quantity of distilled water in the bends of the tubes serving to prevent the entrance of air during the operations, and the connecting tubes (*c*) gently forced down into the infusions. The asbestus tubes (*a*) of the flasks were then connected with aspirators, and the air was drawn at any desired rapidity through the asbestus tubes (*b*), which filtered it, over the surface of the putrescent liquids (*f*) and through the infusions (*d*). By this means, it will be seen, only germs given off from the liquids of the traps could enter the infusions.

To test the third question (experiments 10–13) the form of apparatus just described was at first employed, with the single modification that the asbestus tube (*b*) was drawn out to a capillary tube, which terminated below the surface of the putrescent liquid.

Some difficulty was, however, experienced with this form of the apparatus, as the liquids were gradually forced up the closed arm of the U-tube, a considerable pressure being required to maintain the aspiration through the fine capillary tubes. The experiments required, consequently, very careful watching, and the aspirations could not be carried on constantly and at a very slow, uniform rate. To obviate this difficulty, a straight closed tube was finally employed (experiment 11), as shown in Fig. 7.

In preparing the experiment this tube was first sterilized by heat; the sewage was then added through a funnel, so as not to wet the upper part of the tube, and the tube connected with the flask while the infusion was still boiling, the stopper, however, only being loosely inserted so long as the boiling was continued. The customary precautions were taken to insure the sterility of the connection tube (*c*) and the portion of the tube above the surface of the sewage (*f*). With this form of apparatus the aspiration was constantly maintained.

The results of the experiments confirm the observations recorded by the other experimenters referred to.

At normal summer temperatures no germs were given off from the decomposing liquids whenever their surfaces remained unbroken, even though in some of the experiments the air was continuously conducted over them in a slow current. When the surfaces of the liquids were broken, however, by the bursting of bubbles, germs were invariably given off and the sterilized infusions infected, no matter how slowly the aspiration was conducted.

In most cases (experiments Nos. 10, 12, and 13) the infection of the infusions resulted very speedily; in a single instance (No. 11), where the aspiration was conducted with extreme slowness, it was somewhat retarded, though not ultimately prevented.

In these experiments two possible sources of error occurred to us. The traps and the connecting tubes were speedily coated with moisture from the condensed vapors of the infusions and the trap-liquids. There might thus, it is obvious, be a direct continuity of the liquids in the traps and the cultivating-flasks by means of these thin films of moisture in all the experiments of the second and third sets, as well as in some of those of the first set, for in some instances here the traps were in direct contact with the surface of the cultivating-liquid, and not raised slightly above it, as represented in the figure.

Might not germs then from the trap-contents be conveyed along these moistened surfaces into the sterilized infusion by capillary action, or might these condensed vapors not contain a sufficient amount of germ nutriment to enable fungi to spread from the traps to the infusions?

Although the possibility of direct infection of the infusions in either way seemed extremely slight, yet as the remotest source of error in experiments of this nature should be rigidly guarded against, in some of the tests (Nos. 12 and 13) the bends of the connection-tubes (*c*) were kept perfectly free from moisture during the entire time of experimentation, by means of a gentle heat. This source of error was in these cases, therefore, entirely eliminated. The infusions, however, decomposed as in the other experiments where the aspiration was through the trap-liquids. The results of the other experiments show, furthermore, that inoculation does not take place from such causes.

On the other hand, might not the presence of moisture in the connecting-tubes (*c*) of the second and third sets of experiments have precisely the opposite effect, *i. e.*, to prevent, or at least to retard, the transference of germs from the traps to the cultivation-fluids, in case any were taken up by the air?

This objection, though likewise of no great weight, was the more plausible of the two, as the germs in passing through the long, narrow connection-tube (*c*) might all at some point come in contact with its moistened walls and adhere to them.

To meet the objection control-tests (experiments 14 to 17) were tried. In experiment No. 16 the asbestus was removed from the filter-tube (*b*), so that air which contained germs might be aspirated. In experiments Nos. 14 and 15 no traps were employed; the tubes (*c*) opening downwards, as before, were lengthened to 25^{cm} to increase the possibility of contact; and the aspirations were carried on more slowly than in the tests of the second set. In No. 14 the tube was kept constantly moist, but in No. 15, in which it was drawn out to a long capillary tube, it was allowed to dry. In experiment No. 17 the asbestus was removed from the filter-tube (*b*), which was drawn out to a capillary tube as in experiments 10 to 13, and the aspiration was conducted through sterilized water.

In all of these control-experiments the infusions ultimately broke down. Neither by conducting unfiltered air through sterilized water nor over moistened surfaces can the germs be removed therefrom; though, as a comparison of the tabular results of all the experiments would appear to indicate, the passage of germs is to a certain extent retarded.

We have just stated as one of the results of these experiments that germs are not given off from an infusion at rest to the air at the ordinary summer temperatures. It will be seen, however, from the table that in four experiments of the first set the infusions finally decomposed. Setting aside the result of experiment No. 2 as untrustworthy, the flask having evidently been disturbed,* we have in experiments 1, 4, and 5, cases of decomposition occurring at the expiration of ninety-two, eighty-three, and one hundred and seventeen days, respectively, for which we can at present offer no satisfactory explanation.

The flasks in this set of experiments were by chance all placed on a shelf in the laboratory directly over a furnace register. The temperature of the air immediately surrounding the flasks was thus considerably higher than the average temperature of the room, after the furnace fires were started—about the middle of October. No absolute record of the extreme daily limits of temperature was made until November 18, when, in consequence of the decomposition of No. 1, maximum and minimum thermometers were placed by the flasks. The temperature was frequently observed, however, and found on

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* Naegeli: Die niederen Pilze, u. s. w., München, 1877.

† Carmichael: An experimental investigation into the trap and water-closet system, &c. The San. Jour., vol. iv, No. 49, March 1, 1880, Glasgow.

‡ Wernich: Ueber verdorbene Luft in Krankenräumen, No. 179, Sammlung Klin. Vorträge, Februar, 1880, Volkmann.

§ Miquel: Epuration des eaux d'égouts par le sol de Gennevilliers, Journal D'Hygiène, &c., 1880, 5^e vol., 383 p. Report by Marié-Davy.

* One side of the shorter arm of the trap was, on the date of the decomposition, found to be coated with decomposition products of the putrid infusion up to the edges of the tube.

several occasions to run as high as 35°, and on October 25 to have reached 37°.

The very surprising cases of decomposition at these temperatures suggest the interesting question whether germs may not be taken up by the air at temperatures within the limits of our extreme summer heats, though they are not given off at temperatures but slightly below these

With reference to the effect of temperature upon the transmissions of germs from a liquid to the air, our attention has recently been called by Dr. Bigelow to the statement by Miquel,* that in the evaporation of putrid liquids at temperatures of 40–45°, though not at lower temperatures, the aqueous vapors carry germs with them into the air. On the other hand, Marié-Davy, in the article previously referred to, reports that Miquel in some recent investigations evaporated putrid infusions to dryness at temperatures of 40° and 45° without observing any transmissions of germs.

In our own experiments the temperature has, since November 18, repeatedly reached 39° and occasionally 42° without any further decompositions occurring. It must, however, be remembered that these temperatures have not been maintained for any great length of time.

That germs can be given off from a quiescent liquid to the air, even at high temperatures, has not been directly proven, and we should by no means feel warranted in assuming this as the cause of the decompositions above cited, although we are not at present able to account for them in any other way.

As the tubes were constantly covered with films of moisture from condensed vapors there was no possibility of the bacterial growths drying around the surface-edges of the infusions in the inner arms, nor, were that to happen, would it seem probable, judging from Wernich's* experiments, that germs could become detached and taken up by the air in the flasks.

The other experiments of this series show that germs can neither be carried up the tubes by capillary action nor reach the cultivating-liquids by direct, continuous lines of growth.

The flasks were naturally subject to fluctuations of temperature on account of their location. On the supposition that the traps might at times, under sudden fluctuations of temperature, have been forced, in consequence of the asbestus filter-tubes resisting to a slight degree a rapid egress or ingress of air, control-experiments were at one time made with several of the flasks which had decomposed, by placing them directly over the register, where the temperature was 70–75°, and then removing them quickly to the outer air, the temperature of which was about 0°. At the instants of exposure to the hot and cold air slight displacements of the liquids in the tubes were perceptible; which were, however, only momentary, the air passing freely through the asbestus. On another occasion the flasks were subjected to temperatures of 105° and —7°. Although these changes of temperature were much greater and more sudden than any to which the flasks could have been previously exposed, yet we did not succeed in any instance in forcing the trap-contents over into the infusions.

The fact that the infusions remained perfectly clear for several months and then suddenly and rapidly decomposed, precludes the possibility of their having been incompletely sterilized.

The results of investigations thus far indicate, however, that in experiments on this problem, the temperature must be taken into consideration as one of the factors. In consequence of these results we purpose to continue this entire series of experiments on the transmissions of germs from quiescent liquids, in cultivating-chambers at constant temperatures from 35° to 45°, or even higher if necessary.

*Miquel: Annuaire Meteorologique de Montsouris, 1878, 540 p.

* Loc. cit.

THIRD SERIES OF EXPERIMENTS.

Transmission of germs from a liquid to the air.

No.	Infusion.	Dimensions and forms of apparatus.	Date of experiment.	Dates of aspirations.	No.	Date of decomposition.	Time in— Days.	Time in— Hours.	No. of liters of air aspirated before decomposition.
1*a* 2*b* 3	Beef	Liter flasks with bent tubes (1cm in diameter) as traps, containing water (No. 1); beef infusion (No. 2); urine (No. 3). (See figure 5.)	Aug. 5	....	1*a* 2*b* 3	Nov. 5 Aug. 25	92 20*b*	....	
4*a, c* 5*a, c, d* 6	Beef	Same as above; Nos. 4 and 5 containing beef infusion, No. 6, sewage in the traps.	Aug. 27	....	4*a, c* 5*a, c, d* 6	Nov. 18 Dec. 22	83 117	....	
7 8 9	Beef .... (See note *e*.)	Flasks (500cm3) with U-tubes, (10 × 2cm) as traps, containing beef infusion (No. 7); urine (No. 8); sewage (No. 9). (See figure 6.)	Aug. 12 Aug. 12 Aug. 21	Nos. 7 and 8 daily and continuously from August 13 to August 21, inclusive; and Nos. 7, 8, and 9 continuously from August 24 until September 17, inclusive (excepting August30;) and on September 21, 22, 24, and 25, averaging about 3½ liters a day.	7 8 9	....	....	....	Up to date .... 126 Up to date .... 126 Up to date 102
10	Beef .... (See note *f*.)	Nos. 10, 12, 13, flasks (1 L.) with U-tubes (10 × 2cm), containing sewage (Nos. 10 and 12), and beef infusion (No. 13).	Aug. 21	No. 10 at intervals from August 24 until August 28, inclusive.	10	Aug. 29	....	....	A little more than 2
11		No. 11, flask (1 L.) with straight tube (10 × 2.5cm), containing sewage. (See figure 7.)	Sept. 7	No. 11 continuously and *very slowly* from September 14 to September 25, inclusive; and from October 18 to November 9, inclusive, averaging 333cm3 (September 14 to 25) and about 870cm3 (October 18 to November 9) per day.	11	Nov. 10	....	....	From Sept. 14 to Sept. 25 .... 4 From Oct. 18 to Nov. 9 ....20 In all 24
12		....	Sept. 1	No. 12 at intervals from September 2 to September 3, inclusive.	12	Sept. 4	....	....	Less than....... 2
13		....	Sept. 6	No. 13 at intervals from September 13 to September 15, inclusive.	13	Sept. 16	....	....	300cm3
14	Beef .... (See note *g*.)	Nos. 14 and 15, flasks (1 L.) without traps, and with tubes *c* 25cm in length. In No. 15 tube *c* was drawn out to a capillary tube for 10cm of its length.	Sept. 1	No. 14 continuously from September 2 until September 14, inclusive, averaging 1.846cm3 per day.	14	Sept. 15	....	....	24
15			Aug. 28	No. 15 continuously from August 31 to September 4, inclusive, averaging 1.600cm3 per day.	15	Sept. 4	....	....	8
16*e*		Flask (1 L.) with U-tube, as No. 7, containing water, but with no asbestus in tube *b*.	Sept. 2	No. 16 continuously from September 3 until September 12, inclusive, averaging 1.800cm3 per day.	16	Sept. 13	....	....	18
17*f*		Flask (½ L.) with U-tube, as Nos. 10–13, containing sterilized water.	Sept. 2	No. 17 at intervals from September 3 until September 24, inclusive.	17	Between Sept. 25 and Oct. 13.	....	....	24

a Until October 25 the temperature ranged from about 20° to 35°. Temperature October 25, 37°. From October 25 until November 5 ranged from 30° to 35°; exact limits not known.

b Flask appeared to have been disturbed.

c The extreme limits of temperature from October 25 until November 18 not known with precision; highest observed temperature, 36°.

d Between November 18 and December 22 the temperature (as indicated by a maximum thermometer) ran: on 12 days above 37°; on 9 days above 38°; on 6 days above 39°; on 5 days to 40°; on 3 days to nearly 43°.

e In Nos. 7 and 8 tube *b* terminated just above the surface of the liquid in the trap; tube *c* near upper extremity of the trap. In No. 9 position of tubes reversed, tube *c* terminating directly above the surface of the trap-contents, &c. The temperature ranged from about 20° to 36°—highest observed temperature.

f Tubes *b* terminated in capillary tubes below the surface of the liquid to produce bubbling. Tubes *c* terminated near the surface of the liquids. In Nos. 10 and 11 the bends of tubes *c* were moist; in Nos. 12 and 13 they were kept dry and warm.

g Tube *c* was kept moist in No. 14 by addition of a drop of water from time to time, but allowed to dry in No. 15. In No. 16 it remained moist, the aspiration being over water. In No. 17 the aspiration was through the boiled water, to see how long it would filter out the germs.

In addition to the foregoing investigations, a few experiments have been tried by us to test the effects of carbonic acid under pressure on bacterial growths. To this end, small quantities of beef infusions were put into siphons and the bottles charged, as usual, under a pressure of about 150 pounds. Carbonic acid under this pressure did not in any case prevent the development of organisms, though it apparently retarded it.

We have also begun a series of experiments to determine the rapidity of the spread of bacterial growths along tubes or through columns of sand and other soils moistened with nourishing liquids, the results of which, however, we are not at present able to communicate.

Tests of the permeability and the filtering power of cemented walls are being tried.

SUPPLEMENT No. 14,
National Board of Health Bulletin.

WASHINGTON, D. C., SATURDAY, JULY 23, 1881.

SPECIAL REPORT TO NATIONAL BOARD OF HEALTH—EXPERIMENTAL INVESTIGATIONS RELATING TO THE ETIOLOGY OF THE MALARIAL FEVERS.

[By GEORGE M. STERNBERG, Surgeon U. S. A.]

Having been instructed by the National Board of Health (letter dated Washington, D. C., February 4, 1880) to repeat the experiments of Klebs and Tommasi-Crudeli, made in the vicinity of Rome—as a result of which they announce the discovery of a *Bacillus malariæ*—by a comparative study, made by the same methods, in a recognized malarial locality in this country, I devoted my time almost exclusively to this work during the months of September, October, and November of last year (1880).

Before recording my own experiments, I shall give some account of the experiments of Klebs and Tommasi-Crudeli, so that the reader may judge of the nature of the evidence upon which their conclusions are founded, and of the bearing of my own investigations with reference to these conclusions.

By the kindness of Dr. John Dell'Orto, an Italian physician practicing in New Orleans, I am now in possession of a translation of the entire memoir, (Studi sulla Natura della Malaria, Roma 1879) from which I learn that I did not fully appreciate in advance of my own experiments the value attached by these gentlemen to certain evidence which to me seems to be unreliable and secondary in importance as compared with the temperature curve, which, I think, it will be generally admitted, must be our main reliance for establishing a diagnosis of malarial fever, especially in the case of an animal which, *a priori*, we would scarcely expect to find susceptible to the influence of the malarial poison.

It seems to me that nothing short of a paroxysmal fever, exhibiting marked periodicity as to the recurrence of the paroxysms, and a sufficient number of them to remove the suspicion of apparent periodicity from accidental causes, can be accepted as proof in an experimental investigation of this nature.

I do not find such proof in the temperature charts of Klebs and Tommasi-Crudeli (Plate 1), nor do I find it in my own charts (Plate 2), and my observations give me little confidence in changes in the dimensions of the spleen, the presence of black pigment and an increase in body weight, as evidence of malarial infection in an animal which, so far as we know, is not susceptible to the influence of the malarial poison when exposed to it in the usual manner in which it manifests itself among the human inhabitants of a malarial region.

In order, however, to do these authors justice, I shall quote from their memoir sufficiently to enable the reader to judge for himself of the nature of the evidence upon which they rely.

I may say in advance that the memoir of Klebs and Tommasi-Crudeli shows a careful and painstaking attention to details, and a manifest desire to be accurate and precise in the statement of facts, which indicates a truly scientific spirit, and induces me to accept, without hesitation, the experimental data which they have recorded, although I am obliged to differ with them as to the value of the deductions which they have drawn from their researches.

Extracts from memoir of Klebs and Tommasi-Crudeli, (l. c.)

Attention is called to the fact that in the "Roman fever" it often happens that an intermittent paroxysmal fever is converted into a continued or sub-continued form and entirely loses its characteristic type.

REMARK.—A continued fever is produced in the rabbit by the subcutaneous injection of a variety of substances, and this fever sometimes has a remittent character when there is no suspicion of malarial infection.

The diminution in the weight of the body, which is generally observed in other fevers, is not to be found in malarial fevers, it is only noted at a later stage of the disease. In the first days of the fever, especially when it is of a true intermittent type, the appetite increases, and this explains why there is no decrease in weight. This peculiarity is a characteristic sign of the malarial infection which must be taken into consideration during researches on animals.

REMARKS.—I am not aware that the truth of this statement is generally admitted by the profession, and even if we accept it as demonstrated, so far as man is concerned, very carefully conducted experiments with adult rabbits would be required to eliminate the possibility of gain in weight from natural growth or from improved conditions as to food and comfort.

In my experiment No. 6, in which a rabbit was injected with putrid urine, and suffered an attack of fever which produced death in twelve days, a gain in weight of 103 grams occurred. This was a young rabbit, which was growing rapidly at the time the experiment was made. I have observed a marked increase in other cases in which the fact was not verified by weighing.

During a septic process the form of the spleen is modified in such a way as to present a rounded aspect, or a rotundity of its edges, while in the malarial infection the splenic tumefaction appears like a regular uniform swelling of the whole organ, and the transverse sections resemble those of a normal spleen, but larger in every direction.

REMARKS.—I have not been able to discover any marked differences in form between the spleens of rabbits which have succumbed to unquestionable septicæmia and those in which an attempt was made to produce malarial infection by the subcutaneous injection of material obtained by the methods of Klebs and Tommasi-Crudeli from malarial localities near the city of New Orleans. As to the size of the spleen, which I have compared directly, by weight, with the weight of the body (see Experiments 4, 6, 7, 9, 13, 14, 16, 28, and 33), instead of adopting the plan of Klebs and Tommasi-Crudeli, which consists in measuring the length, breadth, and thickness for the purpose of comparison, I have found it to be larger in undoubted cases of septicæmia (Experiments 6 and 7), produced by the injection of putrid urine and my own saliva, than in other cases in which a solution of fish gelatine or of water inoculated with organisms from swamp-mud was the material injected (Experiments 9, 15). In rabbit No. 8, which received three successive injections (Experiments 8, 10, and 19) of swamp culture-solutions, and which finally succumbed to an injection of water containing surface mud from the gutter in front of my laboratory, the spleen was only $\frac{1}{2451}$ part of the weight of the body, while in rabbit No. 7 (Experiment No. 7), in which my own saliva was injected, the proportion was $\frac{1}{675}$. This proportion seems to depend to a considerable extent upon the age of the animal, being greater in young rabbits.*

Another characteristic sign of the malarial infection is the black pigment from the blood. This sign is not alone observed in the pernicious forms. In less serious cases of the intermittent type of long duration, black pigment may be found in the spleen and sometimes in the marrow of the bones. In the gravest forms of malarial fever this pigment is found in large quantity through all the circulatory system and in many of the organs.

REMARKS.—In my post-mortem examinations of rabbits which have died from the effect of subcutaneous injections, I have been in the habit of examining blood from the cavities of the heart and the tissue of the liver and spleen as soon as these organs were removed from the body. I have never found black pigment in the blood, but have found it in abundance in the spleens of several septicæmic rabbits, in which there could be no suspicion of malarial complication, *e. g.*, in rabbits which died in Philadelphia in January and in Baltimore in April as the result of the subcutaneous injection of human saliva (*l. c.*). Masses of orange-colored pigment are still more commonly found in the spleens of septicæmic rabbits, and in one instance orange-colored pigment was found at one extremity of a spleen, which retained its normal color, while the other extremity, which presented a dark discoloration, contained an abundance of black pigment. I cannot doubt that these masses represent broken-down blood corpuscles, and that the black pigment only differs from the orange-colored as the result of some chemical change which I am inclined to think occurs, sometimes at least, post-mortem.

"The lack of suppuration, or the small amount of suppuration at the point of injection," is spoken of as an indication of value in establishing a diagnosis. My results in this particular have varied considerably, according to the nature of the injected material. When the material used has been my own saliva, or a little surface mud from the gutters of New Orleans, or the "rough material" from the surface of an "artificial marsh" (*Vide* Experiments 9, 13, 20, &c.), diffuse cellulitis has commonly resulted with an exudation into the cellular tissue of bloody serum swarming with bacteria and possessing highly infectious properties. In an experiment in which pus was

* Since writing the above I have examined the spleens of a large number of rabbits, the victims of septicæmia (see special report to National Board of Health in Bulletin No. 44, of April 30, 1881), and I have found the greatest diversity in the size and appearance of this organ. Sometimes it presents no appreciable changes, but commonly it is more or less swollen and discolored, and this tumefaction varies greatly, both as to its amount and as to the resulting shape of the organ. Sometimes it is enlarged in all its dimensions, and at others the length is increased without a corresponding increase in breadth. In a recent post-mortem I found the spleen of a small rabbit (weight 24 ounces) to weigh 34 grains. This animal died from the subcutaneous injection of 1.25^{cc} of hay-infusion, which had been kept in a culture-oven for 24 hours, and which contained *Bacillus subtilis* and micrococci in abundance.

injected but slight local inflammation was produced, but quickly fatal results followed, and metastatic deposits of pus were found in the liver. In my experiments with fish-gelatine solution containing organisms developed as a consequence of inoculation with swamp-mud, &c.—à la Klebs and Tommasi—I have sometimes had considerable abscesses form at the point of injection, and these have sometimes pointed at the center of the belly, the most dependent situation, and sometimes have been absorbed, leaving a little mass of cheesy material in their place. These abscesses have often been quite small, but they have rarely failed to follow the injection of the fish-gelatine solution. My observations, therefore, in this particular, do not correspond with those of Klebs and Tommasi-Crudeli.

As a result of preliminary culture experiments made with material obtained from malarial localities in the vicinity of Rome, our authors discovered a Bacillus which appeared to them to be quite different from *Bacillus subtilis* (Cohn) of hay infusions, and from *Bacillus anthracis* (Koch), and which may be characterized as follows:

Small rods, of 5 to 10 micromillimétres length, which during their evolution become converted into tortuous filaments, which divide into joints by the formation of clear spaces in the protoplasm, or more seldom by means of separating membranes. These filaments produce series of very short joints on the surfaces exposed to the action of the air, and spores are developed in their interior. The spores are situated in the center, or toward the extremities of the joints; they may also be found in the center and at the extremities at the same time; when the division in joints does not occur, they multiply, they become smaller, and fill up the interior of the filaments with a granular mass. As we obtained repeatedly the same forms from these cultures made with the purest gelatine solution, and from several different specimens of soil taken from malarial localities, we conjectured that this plant could perhaps be the bearer of malaria.

The question will at once be asked as to whether I have found the so called *Bacillus malariæ* in malarial localities in the vicinity of New Orleans.

I have certainly found bacilli and minute filamentous algæ, closely resembling the different forms described and figured by Klebs and Tommasi-Crudeli, but see no good reason for conferring upon these particular forms the special distinction of being named *Bacillus malariæ*, in preference to any other of the minute vegetable organisms with which I have found them to be associated.

Figs. 1, 2, and 3, Plate I, are photographic reproductions of the plates which accompany the memoir of Klebs and Tommasi-Crudeli, and represent their so-called *Bacillus malariæ*. I must refer the reader to the original work for a detailed description of the various organisms observed by the authors, and for an account of their culture experiments made with a view to elucidating the life-history of their *Bacillus malariæ*.

A glance at Plate I will show that my photo-micrographs (Figs. 4 to 9) represent a number of minute algæ, some of which resemble very much the forms drawn by Klebs and Tommasi-Crudeli. After a careful study of their figures and of their written descriptions, I do not, however, feel justified in saying positively that I have met the identical organism described by those authors, and, indeed, I am not satisfied from their account that they have not included several distinct forms (species?) under the name of *Bacillus malariæ*. Their description of little rods having a granule or spore at each extremity, and often a third at the center, corresponds with the organism shown in Fig. 3, Plate II, which is from a gelatine culture solution inoculated with swamp mud in accordance with their method. I have recently (May, 1881) found the same form in culture liquids (chicken bouillon, &c.) exposed in the biological laboratory of Johns Hopkins University, Baltimore, and am inclined to believe that this is simply an advanced stage in the development of *B. termo* The same appearance of terminal spores is seen in Fig. 4, Plate I, which is also from a culture experiment made in Baltimore. I have frequently observed rods like these in diarrhœal discharges of men, and of rabbits—the subjects of my experiments.

Many of the rods seen in Fig. 7, Plate I, presented the same appearance under the microscope, although the terminal spores (?) are not distinctly seen in the photograph. This specimen is from the surface of a glass slide exposed over an "artificial marsh" in New Orleans, and it, perhaps, corresponds more nearly than any other of my figures with the drawings and descriptions of our authors.

Fig. 6, Plate I, resembles very closely Fig. 1, copied from the memoir of Klebs and Tommasi-Crudeli. This also is a development from air-borne spores in a culture fluid exposed in the laboratory of Johns Hopkins University in Baltimore.

Fig. 5, Plate I, represents two common species of minute algæ, found in abundance in the gutters of New Orleans. The larger is an Oscillatorea; the smaller, made up of short joints, should probably be referred to Bacillus or Leptothrix.

Fig. 8, from the surface of swamp mud near New Orleans, closely resembles the last described, and Fig. 9, which seems to be identical with the last, was found in the discharges from my own bowels at the time I was engaged in these researches. It was observed on several occasions and in considerable abundance. I may say that I was in my usual health at the time, with the exception of a slight diarrhœa, which did not interfere with my work.

Our authors describe *Bacillus malariæ* as made up of "small rods of 5 to 10 micromillimétres in length, which, during their evolution, become converted into tortuous filaments, &c."

Tufts of tortuous filaments, like those seen in Figs. 7 and 8, Plate II, were found in abundance in my gelatine culture solutions inoculated with swamp mud according to the method of Klebs and Tommasi-Crudeli. I did not, however, find time to trace the life histories of these various organisms, and cannot say whether these tortuous filaments were developed from rods, or if they "divide into joints by the formation of clear spaces in the protoplasm."

It is extremely desirable that the life-histories of all of these minute algæ should be worked out; but, in the absence of definite proof that any one of them is entitled to the special distinction of being called *Bacillus malariæ*, I have not considered it necessary to take time for this study, which, it seemed to me, could be employed to better advantage in attacking, by experimental methods, problems of greater immediate importance.

The fact that the organisms described by Klebs and Tommasi-Crudeli and those represented in my photo-micrographs, are from a malarial locality does not, of course, prove that they are *peculiar to* malarial localties, and far more extended observations will be required to demonstrate the truth or falsity of such an hypothesis. In my own experiments the same organisms were found when the gelatine solution was inoculated with earth taken from the public squares in the city of New Orleans as when swamp mud was used for this purpose.

Our authors having, as they believe, discovered a Bacillus peculiar to malarial localities, say:

It only remains now to proceed to the experimental investigations on animals in order to appreciate the value of this suggestion.

The normal temperature of the rabbit was found to be 39.5 C. (103.1 Fah.).

Researches with material taken from the Pontine Marshes were made upon rabbits Nos. 1, 2, 3, 4, and 5 (see temperature charts, Plate III). The details given in relation to Nos. 1 and 2 will alone be given, as it is believed that this will suffice to fairly represent the nature of the evidence which has been adduced, and I must refer the reader to the original memoir for fuller information.

Parallel researches with the mud of Caprolace.—For these researches we experimented on rabbits 1 and 2. At 10 o'clock a. m., April 16, 1879, 1.6cc of water, which had been obtained three days previously from the mud of Caprolace, was injected under the skin of No. 1, and immediately after 0.6cc of the liquid contained in culture-tube No. 1 was injected in the same way into rabbit No. 2. In this tube, which contained very pure gelatine solution, we had put on the 11th of April a very small quantity of the mud of Caprolace, after which the extremity of the tube was carefully closed with cotton. The tube was kept for three days on a stove at a temperature of 30° to 35° C.*

REMARK.—The precaution of carefully closing the mouth of this tube with cotton was doubtless a proper one, but it can hardly be considered of vital importance when we consider that the gelatine solution was exposed to inoculation with atmospheric germs during the time it was being introduced, and that so far as the germs of bacteria are concerned it is probable that the mud of Caprolace itself contained a full assortment of germs of the more common and widely distributed forms, and especially of *B. termo* and *Bacillus subtilis*. Gelatine solution is a putrescible fluid. A temperature of 30° to 35° is favorable for the development of the bacteria of putrefaction: and it can scarcely be doubted that whatever other organisms were present and whatever may have been the special rôle of each, the common bacteria of putrefaction must have developed abundantly under such circumstances.

Rabbit No. 1 was killed by blood-letting, and an autopsy was made at once, with the following results: At the place of injection, right side of lumbar region, a callosity was observed 4 centimeters in length and 3.5 in width, formed of white connective tissue having a fibrous appearance, and some very large blood-vessels filled with hard and reddish-brown colored thrombi. All around this callosity the subcutaneous tissue was œdematous. The liquid of this œdema, taken immediately by means of capillary tubes, contained a great quantity of small movable corpuscles of an oval or round form, and shining, some of which show on two opposite sides small obtuse prolongations. Besides these, immovable filaments were seen of the maximum length of 5.9001 μ, and of the width of 0.7143 μ. The lymphatic glands of the mesentery were much swollen, and contained a great quantity of whitish liquid. The spleen was enlarged, and measured 55mm in length, 9 in width, and 4 in thickness. Examination of the tissue of the spleen showed a large quantity of dark-brown pigment, in irregular masses. Upon adding to the tissue of the spleen some aqueous humour from the anterior chamber of the eye of the same rabbit (recognized previously as perfectly normal), a great number of small, round corpuscles were seen moving with activity. No alteration was found in the other organs of this animal. In order to determine the nature of the round movable corpuscles found in the spleen, two culture-cells were prepared. In the first was placed the serous liquid of the lymph, in the second a small quantity of spleen pulp diluted with aqueous humour. Both were placed in an oven, and kept at a temperature of 30° to 35° C. Before making the preparation the culture-cells were heated to 120° C., in order to kill all living organisms that might be attached to them. At the end of twenty-four hours the first preparation contained immovable filaments with shining granules (spores), and some small movable rods, sometimes united in couples; also some free oval corpuscles, similar to those contained in the filaments. * * * In the second culture-cell there were, besides many free spores, some filaments with homogeneous protoplasm. These, and especially the smallest, could only be seen with objectives of excellent definition, such as the one-twelfth and one-eighteenth inch of Zeiss, lighted with the apparatus of Abbe. Later, they could be seen well with lower powers.

We see, then, that in both rabbits which were used for this research a fever of intermittent type appeared as a consequence of the injection of the aforesaid substances (Plate I, curves 1 and 2). Soon after the injection a rise of temperature to above 40° C. was verified; on the following day it fell a little lower than the normal; on the third day, there was a slight increase; on the fourth, a new paroxysm of fever appeared, with an evening temperature of 40.85° C. in No. 1, and 40.6° in No. 2. After the fifth day the course of the disease takes a different form: Rabbit No. 1, into which we had injected 1.6cc of water drawn from the mud of Caprolace, maintains a high temperature, with slight variations, during forty-eight hours; while No. 2, into which only 0.6cc of the culture made from the

* The temperature of these rabbits, after the injection of above mentioned liquids, is shown in curves 1 and 2, Plate II. The weight of No. 1 at the outset of the experiment was 1,560 grams and of No. 2, 1,804 grams.

same mud was injected, shows a slight elevation of temperature, with slight quotidian remissions on the fifth, sixth, and seventh days. On the eighth there was a normal temperature; on the ninth a little below the normal in the morning, with a slight rise in the evening. On the tenth we put rabbit No. 2 aside for another research. We see, then, the fever of No. 1 becoming continuous after the second paroxysm, while in No. 2 an almost normal condition follows the second paroxysm. This difference corresponds with the difference in the quantity of the material injected.

With regard to the anatomical alterations found in No. 1, which was killed during the paroxysm of fever, the following are worthy of note: First, the lack of suppuration at the point of injection; second, the increase of all the dimensions of the spleen, especially of the length (55mm, while the normal mean is 38.75mm, which gives to the index of the spleen a value of 1298, almost double the normal (664)); third, the appearance of the same organisms in the liquid injected, at the place of injection, in the spleen and in the lymph. Neither the course of the disease nor these anatomical alterations correspond with those of putrid or septic fever. The increase in the weight of the body between the first and second paroxysms is also worthy of attention.

REMARK.—It is believed that the quotations already made and the temperature charts given in Plate I sufficiently indicate the nature of the evidence upon which Klebs and Tommasi-Crudeli depend to establish their announcement of the discovery of a true *Bacillus malariæ*, and without further remarks I shall proceed to detail the experiments made by myself with a view to confirming, if possible, the results obtained by them by similar experiments conducted at a distant malarial locality.

EXPERIMENTAL RESEARCH.

The locality selected as a suitable place from which to obtain samples of swamp mud for experimental purposes was a point in the suburbs of New Orleans, in the "third district," where the track of the Mobile Railroad débouches from the city to enter the extensive swamp in rear of it, which extends towards Lake Pontchartrain. Suburban dwellings of the poorer sort are situated on the very margin of this swamp, and my friend, Dr. Gustav Deveron, who kindly aided me in making this selection, assures me that cases of malarial fever are common in this part of the city, especially during the months of September, October, and November.

My experiments were commenced in May, by collecting from the surface of dry swamp mud the organic pellicle which is found in such situations. A small quantity of this material was placed in a bottle with distilled water; after a few days this water was found to contain a considerable quantity of spherical bacteria in zooglœa masses.

Experiment No. 1, *May* 12.—Five cubic centimeters of this fluid were injected into the cellular tissue of rabbit No. 1. RESULT, entirely negative. The animal showed no signs of ill health.

Experiment No. 2, *May* 16.—Thirty gallons of swamp air passed through 5 cubic centimeters of distilled water, which was then injected into the cellular tissue of rabbit No. 2. RESULT, entirely negative so far as appearances were concerned. No temperature observations were, however, taken.

Experiment No. 3, *May* 22.—Five cubic centimeters of Cohn's fluid, containing numerous bacteria (*B. subtilis*), injected into the cellular tissue of rabbit No. 3. RESULT, the animal remained in good health.*

As there was no satisfactory evidence that the malarial poison was present in the air passing over the swamps near New Orleans at this season of the year, further experiments were postponed until the autumn.

On the 19th of September, 1880, I obtained two specimens of surface mud from the locality above indicated, two specimens from the river *batture* in front of the city, and two from public squares (Lafayette and Congo) in the city of New Orleans.

These samples were placed in six tin vessels having perforated bottoms, each 4 inches in diameter and 6 deep. These vessels were placed in shallow porcelain dishes, containing water, for the purpose of keeping the mud in the cylindrical tin vessels constantly wet, and producing an "artificial marsh," such as is described by Klebs and Tommasi-Crudeli. I have not considered it necessary in these experiments or in the culture experiments with fish-gelatine solution, to be detailed hereafter, to resort to artificial heat, as was done by Klebs and Tommasi-Crudeli, believing that natural conditions should be maintained as far as possible, and assuming that the normal temperature of the atmosphere, which was from 78° to 85° Fah. at the time these experiments were in progress, was a favorable one for the development of the hypothetical malarial germ, inasmuch as numerous cases of malarial fever gave evidence of the presence of the poison in the vicinity of the swamp from which I obtained my material, and the conditions of temperature at this place evidently could not be very different from those in my laboratory, not more than two miles distant. I also departed from the directions of Klebs and Tommasi-Crudeli, who placed their "artificial marshes" in a ventilating chimney, by placing mine in an open window, so that the direct rays of the sun might fall upon them during the daytime, believing that by so doing I should maintain more nearly the identical conditions under which malaria is given off from a natural marsh.

On the 30th of October a new supply of surface mud from the swamp (same locality) and of sandy loam from the river *batture* was placed in four of the tin vessels already described, and these were kept in an open window of my laboratory as before.

* The Cohn's fluid used in this experiment had been added to water through which swamp air had been passed.

The organisms which appeared upon the surface of the mud in these different vessels were studied by various methods during the time the experiment was in progress—about six weeks—and photomicrographs were made of all that it was thought might possibly be of interest in connection with the investigation in hand. One of the most successful methods of collecting these organisms for study was found to be the following: A thin glass cover, carefully cleaned, was lightly placed upon the surface of the moist mud and left for twenty-four or forty-eight hours. It was then picked up with forceps and placed upon a clean glass slide over a small drop of distilled water. Very commonly minute drops of condensed moisture would be found upon the lower surface of the thin cover, and in this case it was not necessary to use distilled water in the examination. For the purpose of arresting the motion of infusoria and active bacteria, either for photographing or to render their examination with high powers more satisfactory, I very frequently used a weak solution of iodine instead of the distilled water. (Iodine, gr. 1; iodide of potass., grs. 2; distilled water, grs. 100.)

Upon bringing the under surface of a thin cover, which had been exposed and mounted as indicated, into the focus of a good objective, a variety of minute algæ were usually discovered. The most common forms are shown in Figs. 5 and 7, Plate I, and in Fig. 6, Plate II.

These minute algæ, belonging to the Palmellaceæ and Oscillatoriaceæ, together with a few diatoms and infusoria, and a greater or less number of bacteria, were commonly found adherent to the under surface of the cover glass and were in a satisfactory position for immediate study, for staining and photographing, or for mounting permanently in a preservative fluid.

Instead of leaving the cover in position for a day or two, very satisfactory specimens may be obtained for immediate examination by taking a clean cover and pressing it gently with forceps against the surface of the mud. When the proper amount of pressure is used the organisms adhere to it without any earthy matter being picked up. A less satisfactory method, but one which I have employed in imitation of Klebs and Tommasi-Crudeli, is to add a little of the surface mud to distilled water in a test-tube, and, after shaking and subsidence of the heavier portion, to examine the suspended particles. In this case it is necessary to take samples from different parts of the tube, as the organisms near the surface will often be found to differ from those near the bottom.

The following notes will show the character of the organisms found in the samples of mud which were under observation in the experiments here recorded. The various specimens were numbered as follows:

No. 1, from edge of swamp near Mobile Railroad.
No. 2, from edge of swamp near Mobile Railroad.
No. 3, from Lafayette square, New Orleans.
No. 4, from Congo square, New Orleans.
No. 5, from river *batture* in front of city.
No. 6, from river *batture* in front of city.

Nos. 3, 4, 5, and 6 were taken from supposed non-malarial localities for comparison with Nos. 1 and 2 from malarial localities.

September 19.—A little mud from surface of No. 1 was added to distilled water and shaken up in a test-tube. After the earthy matter had subsided the suspended particles were examined with Beck's one-fifth inch and Zeiss's one-twelfth inch objectives, with the following result: Much amorphous vegetable *débris*, which renders the water in the test-tube quite opaque; mingled with this are bodies, motionless or possessing brownian movements only, which resemble bacilli, rod-bacteria, and micrococci or spores, but which it is difficult, in the absence of vital movements, to distinguish with certainty from the vegetable *débris* which simulates all these forms.

September 20—The water in the test-tube has cleared up by deposition of the vegetable *débris*. Upon the surface of the deposit at the bottom of the tube are a few diatoms and *Euglena viridis*. In the supernatant water no moving bodies can be detected, but a few extremely minute spherical bodies are seen, of uniform size (less than 1 μ), single and in pairs. The pairs are evidently joined by some transparent substance, which is not visible, but which holds these spores (?) at a fixed distance one from the other.

REMARK.—Similar spherical bodies, united in pairs, have been obtained, but not in great numbers, in aspiration experiments made in the vicinity of the swamp and also in front of my laboratory in New Orleans. I believe them to be the spores, or more properly, conidia, of one or more species of bacteria, and that the invisible material which holds them together is the transparent remnant of the filament or rod in which they were developed, consisting, perhaps, only of a very delicate cellular envelope, or possibly of a jelly-like substance resulting from the softening down of this membrane. It is impossible to determine with certainty the species or even the genus of Schizomycetes to which these spores should be referred, but as the spores of known bacilli are considerably larger, and the filaments of the spirilla would be longer, if extended, than the distance between these spores, it is probable that they should be referred to Bacterium or Vibrio. That the spores of the bacteria of putrefaction were present in this water was proved later by the rapid development of these organisms in a solution of fish gelatine inoculated with it.

September 21.—In addition to organisms already mentioned this water contains oval ciliated infusoria and long oscillating filaments

Examination of Specimen No. 2, September 19.—A little surface mud was shaken up in a test-tube with distilled water, and after deposition of earthy matter microscopic examination made with same results as obtained in preceding examination. In addition a few elongated filaments were found, having a spore in one end (*Bacillus subtilis*). On the surface of the mud in this test-tube are numerous oscillating bacilli containing a spore at each end, others have three and some even four spores in a linear series, also a few diatoms, monads, and unicellular algæ.

September 21.—The bacilli with included spores (*conidia*) observed yesterday are very active, and three species of filamentous algæ (*Oscillatoriaceæ*) are observed as well as *Euglena viridis*, and the monads and diatoms seen yesterday.

Examination of Specimen No. 3, *September* 21.—A few actively moving spherical bodies, single and in pairs.

Examination of Specimen No. 4, *September* 21.—Much amorphous vegetable *debris*, some minute micrococci having vital movements, and some of same dimensions grouped in fours, also a few actively moving monads.

Examination of Specimen No. 5.—Same as above, also *Euglena viridis*.

CULTURE EXPERIMENTS WITH ABOVE SAMPLES OF EARTH.—On the 21st of September a solution of fish gelatine was made according to the directions of Klebs and Tommasi-Crudeli. This solution after being filtered was maintained at the boiling point, in a water bath, for more than an hour. Half an ounce of the gelatine solution was then placed in each of six small beaker glasses, which were labeled culture Nos. 1, 2, 3, 4, 5, and 6, and were respectively inoculated with a small quantity of the earth from the surface of artificial marshes bearing corresponding numbers. The beakers, of which the capacity was two ounces, were placed upon pieces of plate-glass having a ground surface and covered with a small glass circle. Each one was then covered with a bell-glass (apparatus of Lister).

In obtaining specimens of the fluid in these glasses for microscopic examination, it was my custom to take a drop or two from the top or bottom, as desired, by means of a pipette. To prevent inoculation of one culture fluid by organisms from another, the pipette was heated in the flame of an alcohol lamp before using it anew.

I shall give a somewhat detailed description of the organisms found successively in these different culture experiments before proceeding to an account of the results obtained by injecting these fluids into the cellular tissue of rabbits.

September 22.—Microscopic examination of culture fluids with Beck's one-fifth and Zeiss's one-eighteenth inch objectives.

No. 1 contains numerous highly refractive spherical bodies of 1 μ diameter, motionless, solitary or in pairs; also at surface, *B. termo*.

No. 2 contains the same refractive spherical bodies (spores of bacilli?) at the bottom of the fluid, and upon the surface, *B. termo* and micrococci, solitary and in chains of two or three; also a few rod-bacteria larger than *B. termo* (*B. lineola?*).

No. 3 contains at surface *B. termo*, actively moving spherical bodies and a few rods. At the bottom numerous rods of Bacillus (sp.?).

Nos. 4 and 5.—The same as above, but the bacteria are longer and resemble those found in acid urine of yellow-fever patients. (See "The Bacteria," Plate III, Little, Brown & Co., 1880.)

No. 6.—The same as above, and in addition long, flexible, transparent filaments, and rods having spores at each extremity resembling the *Bacillus malariæ* of Klebs and Tommasi-Crudeli.

September 23, *No.* 1.—The refractive spherical bodies are more numerous than yesterday at the surface of the liquid, where they are associated with *B. termo;* at the bottom are numerous rods having a diameter of 0.7μ and a length of 1.5 to 3μ, which contain a refractive granule (conidium or spore) at each extremity, and in some instances a third in the middle. (See Fig. 3, Plate II.)

No. 2.—Same as above, also upon the surface a few rods considerably larger than those described, and filled with granules. At the bottom flexible filaments with granular contents having a serpentine movement (*Vibrio serpens?*).

No. 3.—Same as No 2.

No. 4.—The same, and also numerous amœbæ, having a transparent rapidly-flowing protoplasm, containing many granules (apparently bacteria, upon which they have been feeding).

No. 5.—The same bacteria as in No. 1.

No. 6.—The same, and some long, slender filaments, less than 1 μ in diameter.

September 24, *No.* 1.—The same bacteria as before described.

No. 2.—At bottom radiating masses of rods and spores, and on surface a mycoderma of *B. termo*.

No. 3—All of the forms of bacteria heretofore described, oval ciliated infusoria and amœbæ, some active and some encysted (Fig. 5, Plate II). Also elongated bacteria of same diameter as those on surface, exhibiting serpentine movements (*Vibrios*).

No. 4.—Bacteria, amœbæ, &c., as above described; also some oscillating filaments.

No. 5.—The same, and a few ciliated infusoria.

No. 6.—Numerous bacteria, with granular contents, having a length of 3 to 5 μ and a thickness of 1 μ form a thick veil (mycoderma) upon the surface of the liquid. (See Fig. 1, Plate II.) *Bacterium termo* also present.

A second culture experiment, marked No. 6–2, was started this day by inoculating fresh gelantine solution with a minute drop of fluid from the surface of No. 6, with the purpose of cultivating the organism above described by itself.

September 26. *No.* 6-2 is covered with a mycoderma of the same bacteria previously found in No. 6. (See Fig. 1, Plate II.)

No. 3.—Contains, in addition to organisms previously described, bacilli, with spores at one extremity, probably as a result of the development of rods from the refractive spores heretofore mentioned. Also bacilli in leptothrix chains and spirilla (*S. volutans?*).

No. 2.—Also contains, in addition to organisms previously described, some amœbæ and large oval cells containing granules. (See Fig. 5, Plate II.)

A thin glass cover examined this day, which had been left upon the surface of artificial marsh No. 1 for forty-eight hours, had adhering to its under surface diatoms (*Navicula*) minute filamentous algæ (*Oscillatorieæ*) and bacteria (*B. termo*). A thin cover from artificial marsh No. 6 had adhering to it long, slender filaments and rods with spores at each end closely resembling those figured by Klebs and Tommasi-Crudeli under the name of *Bacillus malariæ*. (See their Fig. 3, Plate I.)

September 27.—In addition to organisms already described, gelatine solution No. 1 was found to contain numerous tufts of slender, flexible filaments. (See Fig. 7, Plate II.)

REMARKS.—It will be observed that up to the present time a variety of different organisms have made their appearance upon the surface of my artificial marshes, in the test-tubes containing water and earth from these marshes, and in the fish-gelatine culture solutions. Many of these, such as the diatoms, amœbæ, ciliated infusoria, euglena, and the larger oscillatorieæ, are widely distributed and tolerably well known forms. When we come to the more minute algæ and the bacteria, which I have described and photographed, I am not prepared to speak with any great amount of confidence, as there is still much confusion and uncertainty in the descriptions given of these forms, even by such authorities as Cohn, Nägeli, and others, who have devoted the most attention to them.

There is no doubt, however, that the bacteria of putrefaction were present in all of my gelatine culture experiments, as the odor of putrefaction was given off from these solutions within a day or two after inoculation with earth from the sources specified. This was to have been expected, *a priori*, as the gelatine solution is extremely prone to putrefactive changes, and the bacteria of putrefaction are so universally distributed that it would probably be difficult to obtain a sample of earth from any source on the surface of the earth, in temperate regions, which should be quite free from these organisms or their germs. Klebs and Tommasi-Crudeli, who used artificial heat in their experiments with their so-called "artificial marshes" (30–35° C), say:

> The most remarkable result of this arrangement was that almost immediately a great quantity of organisms contained in the grounds and in the muds died. * * * No more moldiness was formed at the surface of the ground or of the vessels, and the phenomena of putrefaction stopped in the marshy muds, while they reached a high degree of putrefaction whenever the same muds were kept under bell-glasses.

The arrest of the phenomena of putrefaction did not dispose of the bacteria of putrefaction already present, and these must have been introduced into the fish-gelatine solution and other liquids inoculated with these muds, and could scarcely have failed to multiply in them.

In my culture experiments *B. termo* took the precedence of all other organisms as to the time of appearance and rapidity of development, with the single exception of No. 6, inoculated with sandy loam from the river *batture*, in which the form represented in Fig. 1, Plate II, was the predominant form, *B. termo* being also present. The rapid increase of these bacteria near the surface of the liquid gave to the previously transparent gelatine solution a clouded appearance. Soon a delicate veil (mycoderma) formed upon the surface consisting of motionless rods of varying length. In some of these rods refractive points were to be seen near the extremities, which are believed to be conidia or spores. These are well shown in Fig. 3, Plate II, in which rods of varying length may be seen, some having a spore at each extremity and others a third one in the center. This photograph is made from a collection obtained from the bottom of culture No. 1, but the same form was present in all of the culture fluids, and, as already stated, I suspect it to be a stage in the existence of *B. termo* and to represent the formation of spores in this organism. In the course of a few days the active life of *B. termo* ceases in these solutions of gelatine and the liquid resumes its transparency, all of the little rods being deposited on the bottom of the vessel. In the meantime the liquid, which was colorless, has acquired a pale amber tint, and has a disgusting glue-factory odor.

Shining oval and spherical bodies of about 1 μ diameter, believed to be the spores of bacilli, were observed in the different culture liquids upon the first examination. These seemed to increase in number, and after two or three days rods commenced to make their appearance, some uniform in diameter and joined in leptothrix chains, others having an expanded spindle-shaped extremity. (See Fig. 9, Plate II.) It is believed that this form represents the development of the spores, already referred to, into rods, and that this organism is the widely-distributed *Bacillus subtilis* which has been carefully observed by numerous microscopists. Vibrios also made their appearance in all of the solutions in greater or less numbers. The specimens represented in my photograph (Fig. 4, Plate II) are from

culture No. 3. At this time also commenced to appear at the bottom of all of these solutions the tufts of radiating flexible filaments shown in Figs. 7 and 8, Plate II. What relation, if any, these flexible filaments bear to the vibrios, Fig. 4, and to the bacteria, Figs. 2 and 3, I am unable to say, but I suspect that they represent a phase in the development of these organisms, or possibly of the baccilli shown in Fig. 9.

In culture No. 6 and in No. 6-2 the bacteria shown in Fig. 1 continued to be the most abundant form up to the time that the following injection experiments were made:

EXPERIMENTS UPON RABBITS.

On the 29th of September, eight days after the commencement of the above-described culture experiments, the following injection experiments were made.

Rabbit No. 4.—Injected into cellular tissue of left flank 0.75^{cc} of gelatine culture solution No. 1, first stirring up from the bottom the deposit containing organisms above described.

Rabbit No. 5.—Injected in the same way (with hypodermic syringe) 0.75^{cc} of culture fluid No. 6-2, first shaking it up so as to distribute through the liquid the deposit at the bottom and the mycoderma upon the surface (*B. lineola?*).

Rabbit No. 6.—Injected in the same way 0.75^{cc} of urine, containing *B. termo*, which had been inoculated two days previously with a drop of putrid meat juice.

Rabbit No. 7.—Injected in the same way 0.5^{cc} of saliva containing epithelial cells, &c., from my own mouth. The following day, September 30, rabbit No. 8 received an injection into the cellular tissue of left flank of 1.26^{cc} of gelatine culture No. 1 (same as rabbit No. 4.

Nos. 4, 5, 6, and 7 were young rabbits of the same litter, and weighed respectively 474, 320, 390, and 304 grams. No. 8 was a full-grown male, weighing 1,922 grams.

In the temperature observations made upon these rabbits, and in subsequent experiments, the thermometer was introduced into the rectum, and usually three daily observations were made, viz, at 8 to 9 a. m., at 12 to 1 p. m., and at 5 to 6 p. m.

The more frequent observations, hourly in some cases, made by Klebs and Tommasi-Crudelli, do not seem to have disclosed any marked oscillations of temperature not shown by three daily observations: and it was quite impossible for me to attempt more frequent observations without additional assistance, unless I should neglect the quite as important daily microscopical examination and photographic record of the organisms found in my culture experiments. A; the result of several observations upon healthy rabbits, the mean normal temperature was found by Klebs and Tommasi-Crudelli to be 39.5° C. (103 1° Fahr.)

This corresponds very nearly with my own observations repeated on various occasions, but it must be borne in mind that variations above and below the normal mean are quite common in healthy rabbits, and that considerable variations may result from trivial causes. Thus the temperature of six healthy rabbits was found (October 15), when they were first brought to my laboratory in New Orleans, to vary from 102.3° to 103.6°; and the temperature of a rabbit upon which three daily observations were made for several days, and which did not receive any injection, and was apparently in perfect health, varied from 102° to 104° Fahr.

This considerable variation in the temperature of healthy rabbits, due chiefly to external causes, but perhaps attributable sometimes to fear, violent exercise, &c., is even more marked in those animals which have received an injury of any kind, or those in which fever has been produced by the subcutaneous injection of any pathogenic material.

As a quickly fatal result followed the injections made in the case of rabbits Nos. 4 and 7, and that without any evidence of paroxysmal fever, remittent or intermittent in character, I shall first detail the history and post-mortem appearances of these animals, and will later call attention to the character of the temperature records in rabbits 5, 6, and 8, of which charts are given. (Plate IV.)

Experiment No. 4.

Rabbit No. 4.—Injection at midday, September 29, temperature at 7 p. m., 103°. September 30, 8 a. m., 103.2°; 2 p. m., 104°; 7 p. m., 104.1°. October 1, 8 a. m., temperature in the rectum below 95° (the lowest point marked on the register of the thermometer). The animal is dull and feeble, and drags its hind legs when it attempts to move. 11 a. m., can no longer sit up, but lies upon its side; has dilated pupils, stertorous respiration, and venous and capillary congestion of ears. 11.30 a. m., contracted pupils, death; rigor mortis ten minutes after death.

Post-mortem examination at 12.45 *p. m.*—Stomach and bowels normal, filled with food and fæces, bladder full, liver dark colored and congested, weight 18 grams; spleen of normal size and appearance, weight 0.32 grams; auricles of heart and large veins filled with dark blood; brain and meninges congested, lungs normal.

Microscopical examination.—At the point of injection some slender filaments and numerous micrococci, single, in pairs, and occasionally in chains of three. Blood from left auricle and the spleen pulp contains the same organisms; leucocytes contain numerous granules of the same diameter as the micrococci referred to.

October 2.—Microscopical examination of culture cell, put up yesterday, containing gelatine solution and a little of the cheesy material from point of injection; shows granular *débris*, slender, flexible moving rods of various lengths, and micrococci.

Microscopical examination of culture cell containing blood from auricle, mounted yesterday at the time of post-mortem; shows micrococci, solitary, in pairs, in chains of three, and in sarcina-like groups of four.

The bladder of this rabbit, filled with limpid urine, was removed, after tying a ligature around the urethra, and placed in a clean saucer under a bell-glass. Microscopical examination of the contents, October 2, showed it to contain granular matter, epithelium from the bladder, and a few micrococci, solitary, in pairs, and in groups. No odor of putrefaction.

When the post-mortem of rabbit No. 4 was made a small portion of spleen pulp, taken from the interior of the organ with instruments previously heated to redness to destroy adherent germs, was carefully placed in pure gelatine solution in a beaker and covered with glass plate and bell glass, as in previous culture experiments. (Lister's apparatus.) This was labeled "Spleen culture No. 1." Upon examining this liquid, October 3, it was found to contain an abundance of *B. termo*, micrococci, and a few vibrios. Examined again October 6, it proved to contain *B. termo* in abundance, and at the bottom the same organism in a quiescent state, and containing terminal spores as shown in Fig. 3, Plate II. This solution was again examined October 15, with the following result: The same bacteria above described, also smaller bacteria, micrococci, and numerous bacilli, with a single terminal spore. The effect produced by the injection of this fluid into the cellular tissue of rabbit No. 13 will be detailed hereafter. A later examination of this fluid, October 18, showed it to contain the above-described organisms and torula-like chains of bacilli, each joint of which contained a spore; also extremely slender filaments, mostly motionless; but some had a serpentine motion and exactly resembled the filaments subsequently found in the blood of rabbit No. 16. (*Septic vibrio* of Pasteur.)

REMARKS.—It is believed that this rabbit died of acute septicæmia, although the symptoms might be interpreted as due to a congestive form of malarial fever. Results obtained in subsequent experiments confirm, however, the first supposition rather than the latter.

Experiment No. 7.

Rabbit No. 7.—Injection at midday, September 29 (0.5^{cc} of saliva). Temperature, 7 p. m., 107.2°. September 30, 8 a. m., 104.8°; 2 p. m., 104.5°; 7 p. m., 106°. October 1, 8 a. m., 106.5°; 2.30 p.m., 106.70°; 7 p. m., 104.2°. October 2, 9 a. m., temperature 98°. Posterior extremities stiff, pupil normal, respiration normal, vessels in ears not congested. Death at 12 m. Post-mortem immediately. Diffuse cellulitis extending from seat of injury, with effusion of bloody serum and inflammatory adhesion of integument to subjacent tissues. Liver not congested, weight 5.2 grams; bladder, empty; intestines, rather empty; hardened fæces in rectum; heart, flaccid; auricles not distended; spleen weighs 0.45 grams.

Microscopic examination of serum from cellular tissue.—Contains blood corpuscles, granular leucocytes, *B. termo*, and micrococci, single and in torula-chains.

Microscopic examination of spleen pulp.—Red blood corpuscles, granular leucocytes, *B. termo* abundant, many shining spores and groups of micrococci.

Spleen culture No. 4.—A portion of the spleen of this rabbit was placed in gelatine solution (Lister's apparatus), and microscopic examination made the following day, which demonstrated the presence of a few motionless bacilli.

October 5.—The same solution contains numerous *B. termo*, and bacilli with spores at one extremity. (Fig. 9, Plate II.)

October 18.—The solution contains the organisms above described, the rods of *Bacillus* being more numerous, some with and some without spores; also free spores, vibrios, and jointed filaments, of which each joint contains a spore resembling in size and appearance the free spores described. The filaments have the same diameter as the rods of bacilli described, and are like those found in spleen culture No. 1.

October 24.—The fluid now contains many oval spores of the bacilli previously described, and slender flexible filaments having a serpentine movement. This fluid was used on October 27 for two injection experiments on rabbits 10 and 11. (See page ——).

REMARKS—It cannot be doubted that in the case of rabbit No. 7, the cause of death was diffuse cellulitis and septicæmia, produced by the subcutaneous injection of ten minims of saliva from my own mouth. Whether this rapidly fatal form of septicæmia was produced by the secretions of my mouth with the contained organisms and histological elements (epithelial cells and mucous corpuscles) because of an unusual septic condition of these secretions due to personal or atmospheric conditions of a temporary character, or whether the same result would follow as a rule at other times and in other places, can only be determined by additional experiments.*

My experiments thus far having demonstrated that fatal septic

* BALTIMORE, *June* 12, 1881.—For results of an experimental research undertaken for the purpose of settling the question here raised, see Special Report to National Board of Health in Bulletin No. 44, April 30, 1881.

results were produced by the subcutaneous injection of my own saliva, and suspecting that the pathogenic properties of the fish-gelatine solution (experiment No. 4) were of the same nature, I subsequently made a variety of experiments with a view to throwing light upon this question. These experiments I shall report in the order which seems most convenient, without reference to the dates at which they were made, and first I shall give *fatal cases.*

Experiment No. 13.

Rabbit No. 12, *October* 7, 9 *a. m.*—Injected into right flank 1.35^{cc} of water shaken up with a little material scraped from the surface of gutter-mud in front of my laboratory (corner Gravier and Rampart streets, New Orleans). Temperature, 1 p. m., 106°; 6 p. m., 107°; October 9, 8.30 a. m., 106°; 1 p. m., 106°; 6 p. m., 109°. October 10, 9 a. m., found dead. Post-mortem examination shows diffuse cellulitis and gangrenous sloughing of the integument and subjacent tissues of the right side of the belly. So extensive has been this sloughing that the intestines are exposed. A very offensive odor of putrefaction is given off from the gangrenous tissues. The rabbit must have died early in the night, and was so offensive that no further examination was made.

Experiment No. 14.

Rabbit No. 13, weight 1,088 grams.

October 15, 10 *a. m.*—Injected 1^{cc} of spleen culture No. 1 into left and the same amount into cellular tissue of right flank. Temperature, 1 p. m., 104.4°; 6 p. m., 102.9°. October 16, 8.30 a. m., 104.2°; 1 p. m., 103°; 6 p. m., 101.5°. October 17, 9.30 a. m., 95°; 12 m., dead. Post-mortem examination immediately. Diffuse cellulitis extending from point of injection. The cellular tissue is infiltrated with bloody serum, which swarms with bacteria; bladder empty; stomach and bowels moderately full; spleen normal in appearance, weight 0.39 grams. The spleen pulp contains micrococci (?) motionless, single, and in masses; liver congested and dark colored, weight 24.5 grams, contains many blood corpuscles, some fat granules and granular leucocytes. Blood from heart contains granular leucocytes and a very few moving spherical bodies,micrococci (?). Cut surface of lung tissue, granular leucocytes, but no organisms recognized.

REMARKS.—The granular condition of the leucocytes here referred to is the rule in these cases of acute septicæmia in the rabbit, and is believed to represent a degenerative change in the protoplasm, which seems to consist at the outset in the formation of little masses, probably albuminoid, of rather regular size, and resembling micrococci. Later a further change seems to occur, resulting in the formation of fat globules. The rather uniform size and the appearance of being sometimes joined in pairs or chains which these granules present, raises a suspicion that they may be vegetable organisms, and possibly this may sometimes be the case, a point which could scarcely be decided by the optical appearances alone. But in my efforts to solve this question by means of reagents and staining solutions, I have not found any support for the hypothesis that they are of a vegetable nature. In certain instances the protoplasm of the leucocytes from the lungs, liver, and spleen of the septicæmic rabbits was found to be diffluent, and to contain numerous actively moving (brownian movement) granules of uniform size, possibly micrococci (?).

Experiment No. 20.

Rabbit No. 18, *October* 18.—Injected into cellular tissue 2^{cc} of water to which had been added, October 10, surface mud from artificial marsh No. 2. This had been shaken up in a test tube and then allowed to stand until the date of the injection. Temperature, 1.30 p. m., 104°; 6 p. m., 103.5°. October 19, 8.30 a. m., 105°; 1 p. m., 106°; 5.30 p. m., 106°. October 20, 8.30 a. m., 100.6°; 1 p. m., dead. Post-mortem examination immediately. Diffuse cellulitis extending from point of injection. Bloody serum from cellular tissue swarms with bacteria (*B. termo*, bacilli, and micrococci). Liver weighs 534 grams, congested. No organisms recognized in scrapings from freshly cut surface of liver, in blood from heart, or in spleen pulp. Liver contains much fat.

Experiment No. 16.

Rabbit No. 15, *October* 15, 10 *a. m.*—Injected into cellular tissue 1.5^{cc} of pus culture No 9 (pus from abscess in flank of rabbit No. 9, which died October 7, was added to fish gelatine solution on the same day and placed in a beaker under bell-glass). A microscopical examination made just before injection showed this solution to contain numerous minute micrococci. Temperature of rabbit, 1 p. m., 105.8°; 6 p. m., 105.2°. October 16, 8.30 a. m., rabbit found dead. Post-mortem examination at once. Cellular tissue infiltrated with bloody serum, which swarms with bacteria and has an offensive odor; bladder full of limpid urine; stomach and intestines normal and full; liver weighs 58 grams, and has a mottled appearance due to leather-colored hue of lobules, defined by red outlines of congested intralobular vessels; cut surface shows an abundance of oil-globules and fatty degeneration of liver cells; many leucocytes in which the protoplasm is diffluent and contains numerous minute granules exhibiting active brownian movements; spleen dark colored and softened, weight 0.78 grams, contains numerous red corpuscles, granular leucocytes and masses of red pigment, also some free oil globules; no organisms recognized. One lung congested; auricles and large veins distended with dark blood. Microscopic examination of blood from auricle; red corpuscles normal, some white corpuscles swarming with actively moving granules like those in liver (micrococci?), a few refractive granules in serum, *and numerous slender filaments* which move across the field with a serpentine motion, pushing aside the red corpuscles in their course. These filaments are less than 1 μ in diameter and vary in length from 50 μ to twice the length of the field of the microscope (Zeiss's one-eighteenth inch objective and low eye-piece). Scrapings from cut surface of lung contain red corpuscles, leucocytes containing moving granules (brownian movement) like those in liver and blood from heart, and actively moving (brownian) granules of same kind in masses external to leucocytes and apparently escaped from them. The organisms found in serum from cellular tissue are vibrios in great number, *B. termo* and micrococci. Some liver tissue compressed under glasss cover shows the flexible filaments (*Vibrio serpens?*) found in blood from auricle in great number and exhibiting very active serpentine movements. Under the influence of iodine solution the flexible filaments are found to consist of a central portion stained by the iodine and a transparent sheath not colored. The central portion is broken in places, but not regularly jointed. These filaments are not changed by soaking for twenty-four hours in solution of caustic potash or in strong liquor ammonia. They are deeply stained by aniline violet, and are without doubt vegetable organisms.*

REMARKS.—The results thus far detailed are tolerably uniform, and there seems no reason to doubt that the fatal effects which followed the injection of the different experimental liquids employed were due to septicæmia, accompanied or preceded, in every instance, except in rabbit No. 4, by diffuse cellulitis extending from the point of injection. The septic fluids which gave rise to this result were: water containing surface earth from artificial marsh (experiment No. 20); water shaken up with algæ, &c., scraped from surface of gutter mud in front of laboratory (experiment No. 13); saliva, from my own mouth (experiment No. 7); fish gelatine solution from swamp culture No. 1 (experiment No. 4); spleen culture No. 1 (experiment No. 14); and pus culture No. 9 (experiment No. 16). A different result occurred in the case of rabbit No. 9, which died of tetanus four days after receiving the injection below indicated.

Experiment No. 9

Rabbit No. 9, weight 1,689 grams.

October 3, 10 *a. m.*—Injected into left flank 1.26^{cc} of water, shaken up with surface mud from artificial marsh No 2, of September 30; 8 p. m., temperature 105.8°. October 4, 9 a. m., temperature 102.4°; 3 p. m., 102.8; 7.30 p. m., 102.6°. Octoter 5, 9 a. m., 102°; 2 p. m., 102°; 7 p. m. 102.4°. October 6, 9 a. m. 101.5°; 1 p. m., 103°; 7 p. m. 104°. October 7, 9 a. m., 103.2°; 1 p. m., dead. It will be observed that after the rise of temperature on the evening of October 3, which has uniformly followed injections made with various fluids, the temperature did not differ materially from the normal until the day before death, when the morning temperature was one and a half degrees below the normal, followed by a rise during the course of the day to 104°, or 1° above the normal. The rabbit commenced to show some rigidity of the muscles of the posterior extremities on the 5th. This had considerably increased by the evening of the 6th, and on the morning of the 7th there was tetanic rigidity of all the muscles of the body, attended with opisthotonos and locked jaws. The pupils were widely dilated, respiration was rapid, and convulsive movements occurred when the animal was disturbed. Death occurred at 9.45. The temperature in the rectum shortly before death was 104°, *shortly after death it was found to be* 111.5°. The animal weighed 1534 grams, a loss of 155 grams since it was previously weighed, at the outset of the experiment. A circumscribed abscess containing stinking pus was found at the point of injection. A drop of this pus was used to inoculate the gelatine solution of *pus culture* No. 9, which subsequently proved so quickly fatal to rabbit No. 15. The bowels were distended with gas, serous fluid and fæces. Weight of spleen 0.51 grams, weight of liver 60 grams. Auricles and large veins distended with blood. Brain and spinal cord normal in appearance. Microscopic examination of serum from bowels shows much granular matter, but no bacteria recognized. Pus from abscess contains numerous bacilli and micrococci.

October 8.—Microscopic examination of blood from auricle placed yesterday in a culture cell; a cluster of spores and numerous sprouting mycelial filaments of *Penicillium glaucum* are found on the edge of the drop of blood. (I think it probable that this resulted from the use of forceps not properly cleaned, which had been used a day or two before in handling rotten banana covered with *Penicillium.*)

* BALTIMORE, MD., *June* 12, 1881.—I am now satisfied that this is the organism described by Pasteur as the vibrio of septicæmia. He says, "*There are as many different septicæmias as there are different vibrios* * * *. In septicæmia the vibrios do not appear in the blood until the last thing, but in this liquid one of them takes a peculiar aspect, often longer than the diameter of the field of the microscope, and so transparent that it easily escapes observation; when, however, it is once perceived it is easily found again, *flexible, climbing, and removing the blood globules as a serpent moves the grass in the bushes,*" &c. (Charbon and Septicæmia, C. R. Ac. des Sc. LXXV, 101-115).

Microscopic examination of pus, placed yesterday in culture cell, shows numerous bacilli and micrococci in irregular groups, and in sarcina-like masses.

To ascertain what effect gelatine solution not containing bacteria might have, when injected into the cellular tissue of a rabbit, the following experiment was made:

Experiment No. 18.

Rabbit No. 17; weight, 1,906 grams.

October 15, 10 *a. m.*—Injected into cellular tissue of right flank 1^{cc} and into left flank 1^{cc} of gelatine solution from stock-bottle containing numerous flocculi of mycelial filaments (*Penicillium glaucum*), but no bacteria. Temperature, 1 p. m., 104.5°; 6 p. m., 105°; October 16, 8.30 a. m., 102.4°; 1 p. m., 103; 6 p. m., 103.8°; October 17, 9.30 a. m., 102.2°; 6 p. m., 102°; October 18, 8.30 a. m., 102.5°; 1.30 p. m., 103°. The rabbit having shown no symptoms of ill-health, except the slight febrile movement immediately following the injection, was now used for another experiment.

Wishing to further test the septic properties of gutter water and the organisms found in it, the following experiments were made: First, to ascertain whether septic poisoning would be produced by the injection of the larger organisms, *Euglena*, ciliated infusoria, filamentous algæ, &c., found in standing but not putrid water, some masses of confervoid algæ (chiefly *Spirogyra*) were gathered from a little pool of standing water in front of my residence, where, owing to a depression in the grading of the street and a neighboring water-plug, I have ready access to a fresh-water aquarium, from which I have been able to obtain at any time during the summer a great variety of organisms, animal and vegetable, for microscopic examination. This locality is but one square and a half from my laboratory, in front of which the septic material was obtained which proved so rapidly fatal to rabbit No. 12; but in this instance my material was obtained from the slimy surface of the mud, which was sometimes covered with water and again exposed to the direct rays of the sun, and putrefactive changes were doubtless occurring in the mass of animal and vegetable matter mixed with the earthy material found on the sides and bottom of a foul gutter.

The bright green filaments of *Spirogyra* and the organisms adhering to them, which furnished the material for the following experiments, were, on the contrary, taken from comparatively pure water, and were not undergoing putrefactive changes.

October 25, 8.30 *a. m.*—Injected rabbit No. 8 (subject of previous experiments not yet recorded), with 1.26^{cc} of the first washings from mass of filamentous algæ collected in front of residence as above described, and rabbit No. 10 with 1^{cc} of fluid obtained by bruising in a mortar with a little rain-water the well-washed filaments of *Spirogyra*.

Experiment No. 24.

Rabbit No. 8.—October 25, temperature, 1 p. m., 105.8°; 6 p. m., 103.6°; October 26, 12 m., 103.8°; 6 p. m., 103.8°; October 27, 8.30 a. m., 103°; 2 p. m., 104.2°; October 28, 8.30 a. m., 103.6°; 2.30 p. m., 104°; October 29, 8.30 a. m., 103.5°; 2.30 p. m., 103.2°; October 30, 8.30 a. m., 103.2°; 3 p. m., 103°. No symptoms having resulted from the injection beyond a temporay rise of temperature immediately following the operation, no further observations were made until November 4, when the animal was made the subject of another experiment.

Experiment No. 25.

Rabbit No. 10, *October* 25, 8.30 *a. m.*—Injected 1^{cc} of water containing chlorophyll and protoplasm from filaments of *Spirogyra*, prepared as above described, into cellular tissue of right flank. Temperature, 1 p. m., 105.5°; 6 p. m., 104.8°; October 26, 12 m., 104.2°; 6 p. m., 104.8°; October 27, 8.30 a. m., 103.6°; 2 p. m., 104.4°; October 28, 8.30 a. m., 103°. At this time the rabbit, being apparently in good health, was made the subject of another experiment.

The above experiments seeming to show that septic results do not follow the subcutaneous injection of infusoria, algæ, &c., not undergoing putrefaction, a further experiment was undertaken to see if septicæmia would follow, after he heavy rains and cool weather which has prevailed in the interim, upon repeating the experiment which gave such a promptly fatal result in the case of rabbit No. 12. For this purpose I collected, on November 4, a quantity of slime from the surface of gutter mud, from which the water had recently receded (shortly after a heavy rain) by scraping off the superficial layer with my pocket knife and placing it in a bottle. This was shaken up with water, and poured into a filter consisting of four thicknesses of fine filtering paper. The filtrate was perfectly transparent, and was used in the following experiment:

Experiment No. 29.

Rabbit No. 5 (subject of previous experiment, but now apparently in good health).—Injected into cellular tissue of flank, 1.26^{cc} of abovementioned filtrate. Temperature, 5.30 p. m., 106°; November 5, 9 a. m., 104°; 3 p. m., 105°; November 6, 8.30 a. m., 104°; 3 p. m., 104°; November 7, 10 a. m., 103.5°; November 8, 9 a. m., 104.2°; 2 p. m., 104°; November 9, 10 a. m., 104.8°; November 10, 3 p. m., 105.2°; November 11, 3 p. m., 106°; November 12, 8.30 a. m., 105°; November 13, 8.30 a. m., 105.6°; November 14, 10 a. m., 105°; November 15, 2.30 p. m., 103.6°; November 16, 2.30 p. m., 103.8°. Observations discontinued, but rabbit remained in apparent good health.

Experiment No. 30.

Rabbit No. 8.—Subject of former experiments but now in apparent good health; has, however, two circumscribed abscesses at site of former injections. November 4, 12 m., injected 1.26^{cc} of unfiltered water shaken up with scrapings from surface of gutter mud as above described. Temperature, 5.30 p. m. 105.2°; November 5, 9 a. m., 103.8°; 3 p. m., 105°; November 6, 8.30 a. m., 104.5°; 3 p. m., 104°; November 7, 10 a. m., 106°; November 8, 9 a. m., 104.2°; 2 p. m., 99°. The animal is very sick; has a watery discharge from left eye, which swarms with bacteria. Blood from ear contains granular leucocytes and a large amount of free granular matter, no organisms recognized. November 9, 8 a. m., found dead. Post-mortem examination immediately. Several cheesy masses the size of filberts at points of former injections. A few drops of greenish pus containing amorphous particles of sand, earthy matter, and many minute bacteria at site of last injection. Inflammatory adhesion of integument, but no cellulitis beyond this. Stomach and bowels moderately full; spleen normal in size and consistence, weight 0.78 grams; liver congested, weight 42 grams; a small amount of fluid in pericardial and pleural cavities; lungs congested; lungs and heart covered with a deposit of lymph, and lungs adherent to chest walls in places. Contents of large intestine examined and found to contain numerous spherical and rod bacteria, and bacilli having a spore at each end like those described and figured by Klebs and Tommasi-Crudeli. Fluid scraped from freshly-cut surface of liver contains granular leucocytes, some with moving granules (brownian) and an abundance of fat globules and granules of various sizes. The spleen pulp contains masses of orange-colored pigment. No organisms recognized.

Microscopic examaination of water used in the above experiment, made November 10, gave the following result: *Euglena viridis*, diatoms, several species of filamentous algæ, including one resembling Klebs's *Bacillus malariæ*, *Zooglœa ramigera*, and a variety of bacteria. The filtered water used to inject rabbit No. 2 was found the following day (November 5) to have on its surface a multitude of minute bacteria and active monads.

REMARKS.—The above experiments seem to show that the fatal septic results which followed the injection in the case of rabbit No. 8 were due to something particulate removable by filtration; yet the filtered liquid produced a continued fever, lasting for several days in the case of rabbit No. 5. The very rapidly fatal result, attended by cellulitis and gangrenous sloughing of the tissues in the vicinity of the puncture, which occurred in the case of rabbit No. 12, may have been due to a greater intensity of the septic poison during the hotter weather of the early part of October, when this experiment was made, or, possibly, to a partially protective influence resulting from the previous injection of septic fluids into the cellular tissue of rabbit No. 8. As the latter case was complicated with pleurisy and pericarditis, believed to be a result of the last injection, but possibly sequelæ of former injections, it is not possible to decide these questions without additional experiments.

To ascertain whether my own saliva retains the septic properties which produced a fatal result in so short a time in the case of rabbit No. 7, the following experiments were made:

Experiment No. 31.

November 12, 9 *a. m.*—Injected 1.26^{cc} of saliva from my own mouth into left flank of rabbit No. 10. This rabbit has a circumscribed abscess the size of a walnut at the site of last injection, but seems to be in good health. Temperature, 2.30 p. m., 105.6°; November 13, 9 a. m., 105.2°; November 14, 10 a. m., 103.8°; November 15, 2.30 p. m., 104°; November 16, 2.30 p. m., 104.2°.

November 21.—The animal has shown no signs of ill-health except the slight amount of fever immediately following the injection.

Experiment No. 32.

Rabbit No. 11, *November* 12, 9 *a. m.*—Injected into left flank 1.26^{cc} of saliva from my own mouth. Temperature, 2.30 p. m., 104°; November 13, 9 a. m., 104.6°; November 14, 10 a. m., 102.5°; November 15, 2.30 p. m., 104.2°; November 16, 2.30 p. m., 104°; *November* 21.—The animal has not shown any signs of ill-health since the injection.

As a negative result followed in the cases just detailed the question arises whether this result, so different from the rapidly fatal effects produced by the injection of the same fluid in September (rabbit No. 4), is to be ascribed to a protection enjoyed by these animals which have already been the subject of experiments with septic fluids, or to a loss of the septic properties which the secretions of my mouth proved to possess during the hot weather. To test this matter the following experiment was made:

Experiment No. 35.

Rabbit No. 20.—A large female rabbit, not previously used in these

experiments, weight 2178 grams. November 18, 11 a. m., injected into cellular tissue of right flank 2^{cc} (in two places) of saliva from my own mouth. Temperature, 5.30 p. m., 105°; November 19, 8.30 a. m., 103°; 2.30 p. m., 103.2°; November 20, 8.30, found dead. Post-mortem examination immediately. Diffuse cellulitis with effusion of bloody serum about point of injection. This serum is swarming with bacteria. Liver weighs 72.5 grams; contains much fat and numerous bacteria. Spleen weighs 1.81 grams. Spleen pulp contains a quantity of pigment granules and numerous bacteria. Blood from auricle contains bacteria.

REMARKS.—It is evident that my saliva still retains its septic properties, and the inference is that rabbits Nos. 7 and 8 did not fall victims to septicæmia because of the protective influence of previous injections of septic fluids. *

To further test the septic properties of gutter mud the following experiment was made:

Experiment No. 34.

Rabbit No. 19, a full-grown male not used in previous experiments *November* 18, 11 *a. m.*—I injected 1.26^{cc} of water shaken up with surface slime scraped from the gutter mud in front of laboratory. The night before was the coldest of the season. Temperature 5.30 p. m., 105°; November 19, 8.30 a. m., 105.2°; 2.30 p. m., 105°; November 20, 8.30, 103.5°; November 21, 10 a. m., 103.5°. November 22, 8.30 a. m., rabbit found dead. Post-mortem examination shows diffuse cellulitis extending from point of injection, with effusion of bloody serum which swarms with bacteria.

To ascertain whether the septic culture fluids, which, in October, produced speedy death in rabbits Nos. 13 and 15, still retain their poisonous character, the following experiments were made:

Experiment No. 33.

Rabbit No. 16.—Subject of previous experiments.

November 12, 12 *m.*—Injected into left flank 1^{cc} of pus culture No. 9 (the same fluid which proved quickly fatal to rabbit No. 15). This fluid had been undisturbed for a considerable time, and care was taken to take up in the syringe only the transparent supernatant fluid, leaving the deposit at the bottom undisturbed. Temperature, 2.30 p. m., 104.8°; November 13, 9 a. m., 103.8°; November 14, 10 a. m., 104°; November 15, 2.30 p. m., 103.8°; November 16, 2.30 p. m., 103.8°. November 21, the animal remains in apparent good health.

As the negative result in this case might be ascribed to protection due to previous injections, or to the absence of organisms in the undisturbed upper portion of the fluid of my culture experiment, the following experiment was made:

Experiment No. 37.

Rabbit No. 22.—A young rabbit (less than two months) not previously injected.

November 18, 11 *a. m.*—I injected 0.5^{cc} of pus culture No. 6 into cellular tissue of right flank. The fluid was thorougely stirred before filling the syringe so as to include the organisms deposited upon the bottom of the beaker. Temperature, 5.30 p. m., 102.5°; November 19, 8.30 a. m., 102°; 2.30 p. m., 105°; November 20, 8.30 a. m., 104.6°; 4 p. m., 103.8°; November 21, 10 a. m., 103°. The animal remained in good health.

REMARKS.—It is evident that this culture fluid has lost the virulent properties which it possessed in October.

The experiments thus far detailed seem rather to relate to a study of septicæmia than of malarial poisoning. Let us now see if evidence more favorable to the conclusions of Klebs and Tommasi-Crudeli can be deduced from the following experiments, in which a fatal result did not follow the injections made.

The oscillations of temperature in these cases will, for convenience of study, be shown graphically (see Plate IV).

Experiment No. 5.

Rabbit No. 5.—A half-grown animal, weighing 320 grams.

September 29.—Injected 0.75^{cc} of gelatine culture solution No. 6–2, containing bacteria shown in Fig. 1, Plate II (*B. lineola?*). On the morning of October 5 a second injection was made of 1.26^{cc} of the gelatine solution from culture experiment below described. On the morning of September 21 one fluid drachm of fresh gelatine solution was placed in a 2-ounce bottle; and by means of a water aspirator, which was placed upon the sidewalk in front of my laboratory, twenty gallons of air were projected through a small orifice against the surface of the gelatine solution. The following day a microscopical examination with Zeiss's one-twelfth-inch objective demonstrated the presence in this fluid of amorphous vegetable *debris*, some cells of 2–3 μ in diameter, spores of bacilli (?) solitary, in pairs and in groups, and a few motionless rods, one seen with a spore at the extremity. September 23.—*B. termo* and bacilli having a spore at each extremity, resembling the *Bacillus malariæ* of Klebs and Tommasi-Crudeli. September 24.—The same as above and radiating masses of rods and spores. September 28.—Same as previously described. October 5.—Contains vibrios, bacilli, micrococci, and rod-bacteria of many shapes and sizes. At this date 1.26^{cc} of this fluid was injected into the cellular tissue of rabbit No. 5, as indicated by the perpendicular line in the temperature chart.

It will be seen that this chart taken as a whole represents a remittent or intermittent fever of very irregular character. The first portion of the curve representing the period between the dates of the first and second injections, shows an initial fever lasting two days, followed by a period of depression below the normal of nearly two days' duration, a second rise to a point 1° above the normal, followed by a second fall to 1° below on the following day. If we refer to charts 8, 10, 11, 16, and 17 on the same plate, we shall see that something like this occurred in each of these cases. We have an initial fever immediately following the injection, a period of depression below the normal, and a subsequent fever of remittent character, in which there is a certain tendency to a daily remission in the morning, followed by an exacerbation of fever usually occurring in the middle of the day. I call attention in the first place to the resemblance of these temperature charts to those of yellow fever, in which we have also an initial fever of a single paroxysm, followed by a depression below the normal, and a subsequent reactionary fever of remittent character. I attribute this resemblance to the fact that both diseases are the result of septic poisoning, although presumably of a different kind. And the remittent character of this fever, which is shown to a greater or less degree in the different charts to which attention is called, cannot, I believe, be fairly compared with the paroxysmal remittent and intermittent fevers in man, due to the widely diffused malarial poison. In the first place the remittent character, which is best shown in charts 10 and 11, is for the most part confined within limits ranging only a little more than a degree above or below the normal. In the second place the depression occurs during the night and early morning, when the external temperature is lowest, and the exacerbation during the middle of the day, when the external heat is greatest. From observations upon healthy rabbits I am led to believe that such diurnal variations within a somewhat more restricted range are rather the rule than the exception; and in a sensitive animal suffering from any injury likely to cause fever, and especially from septicæmia, these fluctuations of temperature in response to external conditions are not surprising, and would rather be looked for than otherwise. I therefore look upon this as an irritative fever, the result of septic poisoning, rather than as evidence that some special organism capable of producing malarial fever in rabbits has been injected along with the septic organisms, which have evidently been present in all of my culture fluids.

In chart No. 6 it will be noticed that the curve differs from those we have just analyzed; in that the temperature did not at any time fall below the normal, and that a continued fever, which reached the highest point recorded in any case (107.5°) on the sixth day, finally resulted in death on the twelfth day. In this case the fluid injected was putrid urine, which had been inoculated two days previously with a minute drop of putrid meat-juice containing *B. termo*.

The following is a history of the case:

Experiment No. 6.

Rabbit No. 6.—Half-grown animal of the same litter as Nos. 4, 5, and 7; weight, 390 grams. Injected 0.75^{cc} of urine into cellular tissue of right side at 12 m.

September 29.—The animal became thin and feeble several days before death, which occurred October 11, and had a mucous diarrhœa. The discharges were found to contain a great variety of bacteria, among others some resembling the *B. malariæ* of Klebs and Tommasi-Crudeli. A little encysted cheesy matter was found at points of injection. The spleen weighed 0.39 grams and the liver 2.07 grams. On the 15th a culture cell, containing blood taken from the auricle of this animal, was examined with Zeiss's one-twelfth inch objective, and no organisms were discovered. Another culture cell, containing a drop of boiled urine and a little spleen pulp, collected with care from interior of organ, was found to contain numerous micrococci in pairs, chains, and zooglœa masses.

Experiment No. 8.

Rabbit No. 8.—Large male; weight, 1,922 grams. Injected 1.25^{cc} of gelatine culture fluid No. 1 (from artificial marsh No. 1) at 8 a. m., September 30. A second injection (experiment No. 10) of 1.26^{cc} gelatine culture No. 2 was made at 10 a. m., October 7. A third injection of 2^{cc} of same solution injected at two points (1^{cc} in each) at 1.30 p. m., October 18 (*experiment No. 19.*)

It will be seen by referring to the temperature chart (No. 8, Plate IV) that a paroxysm of fever followed each injection, but that no evidence of a remittent or intermittent character was exhibited, except after the second injection. The record for eight days following this injection might be supposed to sustain the hypothesis that the fever was of a malarial nature, if supported by a sufficient amount of trustworthy evidence of the same kind. Unfortunately, a study of the temperature charts of other rabbits made the subject of experiment, including my own and those operated upon by Klebs and Tommasi-Crudeli, gives but little support to this hypothesis.

* BALTIMORE, *June* 12, 1881.—This inference has been sustained by subsequent observations (See special report to National Board of Health.)

serum from cellular tissue, spleen, &c.), possess virulent properties. In other words, an infectious disease is produced which may be transmitted from animal to animal by inoculation.

Among the organisms found upon the surface of swamp-mud, near New Orleans, and in the gutters within the city limits are some which closely resemble and, perhaps, are identical with the *Bacillus malariæ* of Klebs and Tommasi-Crudeli; but there is no satisfactory evidence that these, or any other of the bacterial organisms found in such situations, when injected beneath the skin of a rabbit, give rise to a malarial fever corresponding with the ordinary paludal fevers to which man is subject.

The evidence upon which Klebs and Tommasi-Crudeli have based their claim of the discovery of a *Bacillus malariæ* cannot be accepted as sufficient; (*a*) because in their experiments and in my own the temperature curve in the rabbits operated upon has in no case exhibited a marked and distinctive paroxysmal character; (*b*) because healthy rabbits sometimes exhibit diurnal variations of temperature (resulting apparently from changes in the external temperature), as marked as those shown in their charts; (*c*) because changes in the spleen such as they describe are not evidence of death from malarial fever, inasmuch as similar changes occur in the spleens of rabbits dead from septicæmia produced by the sub-cutaneous injection of human saliva;* (*d*) because the presence of dark-colored pigment in the spleen cannot be taken as evidence of death from malarial fever, inasmuch as this is frequently found in the spleen of septicæmic rabbits (*l. c.*).

While, however, the evidence upon which Klebs and Tommasi-Crudeli have based their claim to a discovery is not satisfactory and their conclusions are shown not to be well founded there is nothing in my researches to indicate that the so-called *Bacillus malariæ*, or some other of the minute organisms associated with it, is not the active agent in the causation of malarial fevers in man. On the other hand there are many circumstances in favor of the hypothesis that the etiology of these fevers is connected, directly or indirectly, with the presence of these organisms or their germs in the air and water of malarial localities.

The truth or falsity of this hypothesis can only be settled by extended experimental investigations, and while further experiments upon animals may lead to more definite results it seems probable that the *experimentum crucis* must be made upon man himself.

In a disease not of a fatal character and one for which we have a prompt and reliable remedy, it would seem that subjects for experiment might be found, especially among medical men and medical students, who have always shown themselves ready to subject themselves to inconvenience or even to danger in the pursuit of scientific discoveries of value to mankind.

The method of conducting such experiments which seems to me to promise the best results is the isolation and cultivation of the various organisms found in malarial localities which may possibly be concerned in the production of malaria, a careful study of the life-histories of these organisms, and an experimental investigation of the physiological action of each when taken into the stomach, or respired in a dry state, by healthy individuals. Such a study, to be of value, will necessarily involve a considerable expenditure of time and money, and requires that the experimenters shall be familiar with the most approved methods of making culture-experiments and with the technique of microscopical manipulations with high powers, improved illuminating apparatus, &c.

Another method worthy of trial in connection with this would be to carefully study the bacterial organisms found in the mouth and alimentary canal of persons suffering from malarial fevers† as compared with the common forms constantly found in the same situations in healthy individuals, with reference to the determination of the presence of unusual forms or of an abnormal abundance of common forms, or of possible physiological varieties of these forms not possessing morphological peculiarities.

Finally, I may say that I entered upon this investigation without prejudice, but hoping that I might be able to confirm the conclusions of Klebs and Tommasi-Crudeli, whose researches were evidently prompted by a truly scientific spirit, and were conducted in accordance with strictly scientific methods. I believe that their work will prove useful in many ways to future explorers in this field, and have an abiding faith that light will eventually be shed upon this and similar problems by the persistent and intelligent application of the experimental method supported by all the resources of modern science.

* This statement is based upon observations made subsequently to those recorded in this report. (See special report to National Board of Health. "A fatal form of septicæmia in the rabbit, produced by the sub-cutaneous injection of human saliva."—*Bulletin, No.* 44, *April* 30, 1881.)

† I do not refer to an examination of the blood, as a careful search in a considerable number of cases with a Zeiss's one-eighteenth-inch objective has failed to demonstrate the presence of any organisms in the blood of patients suffering from pronounced malarial fever. The absence of "germs" from the blood does not, however, settle the question against the supposition that these fevers are parasitic germ diseases, as the pathogenic organism may find a congenial habitat in the alimentary canal, in the lymphatics, or elsewhere, and may not thrive in the blood-stream itself. In the fatal form of septicæmia which I have recently investigated the micrococcus multiplies abundantly in the sub-cutaneous connective tissue from the moment that it is introduced by injection, but it does not enter the blood until the case is near a fatal termination. Pasteur has found the same to be the case in a form of septicæmia studied by him in which the pathogenic organism is a long and slender vibrio.

Before concluding this report, I desire to express my obligations to Dr. Gustav Devron, of New Orleans, for numerous favors and for assistance rendered during the prosecution of this investigation; and to Dr. John Dell' Orto, of New Orleans, for a translation of the memoir of Klebs and Tommasi-Crudeli, a labor which he voluntarily undertook in the midst of active professional work, and for which he has my sincere thanks.

DESCRIPTION OF PLATES.

PLATE I.

Figs. 1, 2, *and* 3.—The *Bacillus malariæ* of Klebs and Tommasi-Crudeli; reproduced by photography and the heliotype process from their figures. (See their mémoir Studi sulla Natura della Malaria, Roma, 1879.) The figures are reduced to about four-fifths the original size. (See p. 2, for description of the *Bacillus malariæ*.)

Fig. 4.—Bacteria from surface of *bouillon*, exposed in biological laboratory, Johns Hopkins University, Baltimore, Md., May, 1881. × 1,000 diameters by Zeiss's one-eighteenth objective.

Fig. 5.—Minute filamentous algæ, Oscillatorieæ and Leptothrix, from gutter-water New Orleans; common and widely distributed species. × 180 diameters.

Fig. 6.—Bacilli in leptothrix chains, resembling Klebs and Tommasi-Crudeli's Fig. 1, from surface of *bouillon* exposed in laboratory Baltimore, Md. × 1,000 diameters by Zeiss's one-eighteenth-inch objective.

Fig. 7.—Protococcus (changed in appearance by iodine staining), and minute bacilli from surface of glass-slide exposed over swamp mud—"artificial marsh"—in laboratory, New Orleans, September, 1880. Some of these bacilli presented the appearance of having spores at each extremity like those figured by Klebs and Tommasi-Crudeli. × 1,000 diameters by Zeiss's one-eighteenth-inch objective.

Fig. 8.—Minute alga, (Leptothrix), from surface of swamp mud near New Orleans, September, 1880. Common also in gutter-water. × 1,000 diameters by Zeiss's one-eighteenth-inch objective.

Fig. 9.—The same alga, apparently, as that shown in last figure, from diarrhœal discharges of Dr. S. while in New Orleans, September, 1880. This form was quite abundant and was observed on several occasions. With the exception of a slight diarrhœa, the subject was in good health at the time. × 1,000 diameters by Zeiss's one-eighteenth-inch objective.

PLATE II.

Fig. 1.—Mycoderma (*Bacterium lineola?*) from surface of fish-gelatine solution, culture No. 6 (see page 4), inoculated with mud from bank of Mississippi River, New Orleans, September, 1880, × 1,500 diameters by Zeiss's one-eighteenth-inch hom. oil im. objective.

Fig. 2.—Bacteria from surface of fish-gelatine solution inoculated with swamp mud (see page 5), culture experiment *à la* Klebs and Tommasi. × 1,500 diameters by Zeiss's one-eighteenth-inch objective. New Orleans, September, 1880.

Fig. 3.—The same as Fig. 2 from bottom of gelatine culture—solution, showing spores (?) at each extremity and sometimes a central spore like those described by Klebs and Tommasi-Crudeli. × 1,500 diameters by Zeiss's one-eighteenth-inch objective. This and the preceding figure are from preparations stained with sulphuric acid and iodine solution. (See account of method in Monthly Microscopical Journal, April, 1881.)

Fig. 4.—Vibrios in gelatine solution (culture experiment), New Orleans, September, 1880. × 1,000 diameters by Zeiss's one-eighteenth inch objective.

Fig. 5.—Encysted amœbæ and vegetable organisms developed in fish-gelatine solution (culture experiment). (See p. 4). New Orleans, September, 1880. × 1,000 diameters by Zeiss's one-eighteenth-inch objective.

Fig. 6.—*Protococcus* from surface of glass slides exposed over swamp mud—"artificial marsh." Common form in and about New Orleans. × 400 diameters by Beck's one-fifth-inch objective.

Fig. 7. Masses of flexible filaments found in abundance at bottom of fish-gelatine solution; culture experiment *à la* Klebs and Tommasi-Crudeli. (See page 4). New Orleans, September, 1881. × 1,425 diameters.

Fig. 8.—Same as Fig. 7. × 1,000 diameters. Iodine staining.

Fig. 9.—Bacilli (*B. subtilis?*) with spores at one extremity from culture cell containing serum from cellular tissue of septicæmic rabbit. × 650 diameters by Zeiss's one-twelfth-inch objective. This form was frequently found in culture fluids exposed in my laboratory in New Orleans, and also in abundance in the fish-gelatine culture experiments.

PLATE III.

Temperature charts of rabbits reproduced from the memoir of Klebs and Tommasi-Crudeli. The scale has been changed from Centigrade to Fahrenheit for the convenience of American readers. In this and the following plate the horisontal lines indicate degrees of temperature, and the normal temperature of the rabbit (about 103°) is indicated by a heavier line. The perpendicular lines indicate days.

This fragmentary evidence, which is open to the criticism already made, viz, that the fluctuations may be due to the diurnal variations in the external temperature, can hardly be relied upon for establishing a diagnosis of malarial fever. It should be noted that the injections in the case of this rabbit produced in every instance a circumscribed abscess. One or two of these abscesses, after a considerable time, pointed externally.

Experiment No. 11.

Rabbit No. 10.—Adult male, weight 1,534 grams.

October 8, 12 *m.*—Injected into cellular tissue of flank 1.35^{cc} of gelatine culture No. 2. No abscess followed this injection, so that the case may be considered an uncomplicated one. The temperature chart is believed to represent a non-fatal case of septicæmia, and calls for no special remark beyond what has already been said.

Experiment No. 28.

On the 28th of October this rabbit, being apparently in good health, received an injection of 1.3^{cc} of spleen culture No. 4, the bacilli and other organisms already described being stirred up from the bottom before filling the syringe. A sharp paroxysm of fever followed this injection, but temperature observations were not made after the third day. The animal remained in apparent good health, and on the 12th of November was used for another experiment already detailed.

Experiment No. 12.

Rabbit No. 11.—Adult female, weight 1,410 grams.

October 7, 12 *m.*—Injected 1.35^{cc} of spleen culture No. 1 into cellular tissue of right flank. An abscess formed at point of injection which discharged itself at the centre of the belly. The temperature curve, shown in Chart 11, Plate IV, calls for no special remark.

Experiment No. 26.

On the 29th of October a second injection of 1.26^{cc} of spleen culture No. 4 was thrown into the cellular tissue of right flank of rabbit No. 11. In this case care was taken not to disturb the organisms deposited at the bottom of the beaker, only the transparent supernatant fluid being used for the injection. The result was not very different from that obtained in the case of rabbit No. 10, in which the organisms were stirred up from the bottom before filling the syringe. In neither case did any noticeable result follow, beyond the temporary paroxysm of fever immediately following the injection.

Experiment No. 17.

Rabbit No. 16.—Weight 1,596 grams.

October 13, 10 *a. m.*—Injected into subcutaneous connective tissue of left flank 2^{cc} of culture fluid No. 6–2 (containing bacteria, shown in Fig. 1, Plate II). The temperature curve is shown in Chart 16, Plate IV. In this case the initial fever produced by the injection, and immediately following it, was higher than in any other instance. Attention is especially called to the remarkable resemblance of this chart to that of many cases of yellow fever.

Experiment No. 21.

Rabbit No. 17.—Adult male, weight 62¼ oz.

October 18, 2 *p. m.*—Injected 1.26^{cc} of gelatine solution from culture experiment No. 4, containing numerous filaments (see Fig. 8, Plate 2), and vibrios (see Fig. 4, Plate II).

The temperature curve is shown in Chart 17, Plate IV, and calls for no special remark.

Tabular statement of injection experiments upon rabbits.

Experiment.	Rabbit.	Date of injection.	Nature and amount of material injected.	Result.	Weight of rabbit in grammes.	Weight of spleen in grammes.	Proportion.	Reference to text.
No.	*No.*	1880.						
1	1	May 12	5 c. c. of distilled water, containing organisms from surface of swamp mud.	Negative				See page 3.
2	2	May 16	5 c. c. of distilled water, containing particles from 30 gallons of air (vicinity of swamp).	......do				See page 3.
3	3	May 22	5 c. c. of Cohns fluid, containing bacteria	......do				See page 3.
4	4	Sept. 29	0.75 c. c. of gelatine culture solution No 1	Died October 1	474	.32	$\frac{1}{1481}$	See page 5.
5	5	Sept. 29	0.75 c. c. of gelatine solution No. 6–2	Fever not fatal	320			See page 8.
6	6	Sept. 29	0.75 c. c. of urine, containing bacteria of putrefaction	Died October 11	390 and 493	.39	$\frac{1}{1000}$	See page 6.
7	7	Sept. 29	0.50 c. c. of saliva (Dr. S.)	Died October 2	304	.45	$\frac{1}{675}$	See page 5.
8	8	Sept. 30	1.26 c. c. of gelatine culture solution No. 1	Fever not fatal	1922			See page 8.
9	9	Oct. 3	1.26 c. c. of water shaken up with surface mud from swamp.	Died October 7	1689 and 1534	.51	$\frac{1}{3317}$	See page 6.
10	8	Oct. 7	1.35 c. c. of swamp culture No. 2 (gelatine solution)	Fever not fatal				See page —.
11	10	Oct. 7	1.35 c. c. of swamp culture No. 2 (same as above)	......do				See page 9.
12	11	Oct. 7	1.35 c. c. of spleen culture No. 1	......do				See page 9.
13	12	Oct. 7	1.35 c. c. of water from gutter mud	Died October 10				See page 6.
14	13	Oct. 15	2 c. c. of spleen culture No. 1	Died October 17	1088	.39	$\frac{1}{2789}$	See page 6.
15	14	Oct. 15	2 c. c. of swamp culture No. 2 (gelatine solution)	October 19	1057	.39	$\frac{1}{2710}$	See page —.
16	15	Oct. 15	1.5 c. c. of pus culture No. 1	October 16	1959	.78	$\frac{1}{2511}$	See page 6.
17	16	Oct. 15	2 c. c. gelatine culture No. 6–2	Fever not fatal				See page 9.
18	17	Oct. 15	2 c. c. gelatine solution from stock bottle, containing *Penicillium*.	Slight fever				See page 7.
19	8	Oct. 18	2.5 c. c. of swamp culture No. 2 (gelatine solution)	Fever not fatal				See page 6.
20	18	Oct. 18	2 c. c. of water from swamp mud	Death October 20				
21	17	Oct. 18	1.26 c. c. gelatine culture No. 4	Fever not fatal				See page 9.
22	16	Oct. 24	1.26 c. c. filtered liquid from gelatine culture No. 6–2	Slight fever				See page —.
23	17	Oct. 24	1 c. c. of unfiltered remnant of above liquid.	Fever not fatal				See page —.
24	8	Oct. 25	1.26 c. c. washings of *Spirogyra*, etc	Slight fever; not fatal				See page 7.
25	10	Oct. 25	1 c. c. of bruised *Spirogyra*, etc	......do				See page 7.
26	11	Oct. 27	1.26 c. c. of spleen culture No. 4 (supernatant liquid)	Fever not fatal				See page 9.
27	11	Oct. 28	The above injection repeated	......do				See page —.
28	10	Oct. 28	1.3 c. c. of spleen culture No. 4 (stirred up from bottom)	......do				See page 9.
29	5	Nov. 4	1.26 c. c. of water, containing surface mud from gutter, filtered.	......do				See page 7.
30	8	Nov. 4	1.26 c. c. of same solution as above, not filtered	Died November 9	1912	.78	$\frac{1}{2451}$	See page 7.
31	10	Nov. 12	1.26 c. c. of saliva (Dr. S.)	Fever not fatal				See page 7.
32	11	Nov. 12	......do	Slight fever				See page 7.
33	16	Nov. 12	1 c. c. of pus culture No. 6	Fever not fatal				See page 8.
34	19	Nov. 18	1.26 c. c. of water, containing surface mud from gutter	Died November 22				See page 8.
35	20	Nov. 18	2 c. c. of saliva (Dr. S.)	Died November 20	2178	1.81	$\frac{1}{1203}$	See page 7.
36	21	Nov. 18	0.5 c. c. of spleen culture No. 4					
37	22	Nov. 18	0.5 c. c. of pus culture No. 6	Fever not fatal				See page 8.

CONCLUSIONS.

A great number of minute algæ, including bacteria of various forms, are found upon the surface of swamp-mud in the vicinity of New Orleans, and also in the gutters within the city limits.

Many of these forms may be successfully cultivated in fish gelatine solution (method of Klebs), and this fluid, previously innocuous, acquires pathogenic properties as the result of inoculation with these organisms.

It is evident that the pathogenic properties acquired by gelatine solution and other organic liquids after inoculation with bacterial organisms is due, directly or indirectly, to the presence of these bacteria, for, if they are excluded, such fluids may be kept indefinitely without undergoing change, and are innocuous when injected beneath the skin of a rabbit.

Some of the organisms found in swamp-mud, in gutter-water, and in human saliva are capable of multiplying within the body of a living rabbit, and the fluids and organs containing them (blood,

PLATE I.

FIG. 1.

FIG. 2.

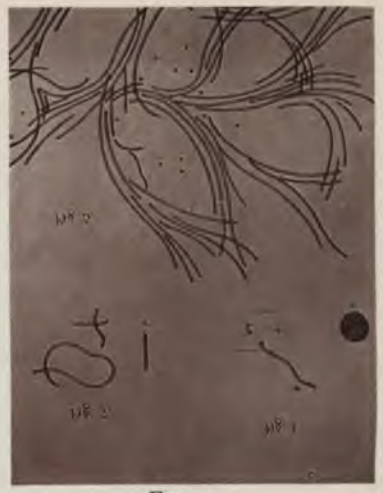


FIG. 3.

FIG. 4.

FIG. 5.

FIG. 6.

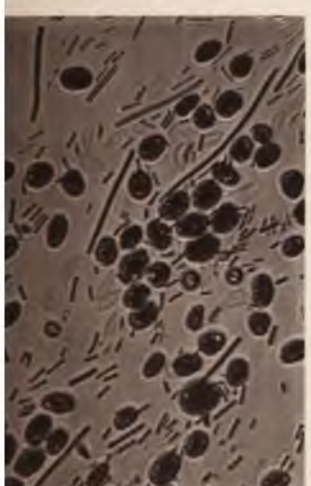


FIG. 7.

FIG. 8.

FIG. 9.

HELIOTYPE PRINTING CO., BOSTON.

PLATE II.

FIG. 1.

FIG. 2.

FIG. 3.

FIG. 4.

FIG. 5.

FIG. 6.

FIG. 7.

FIG. 8.

FIG. 9.

HELIOTYPE PRINTING CO., BOSTON.

Plate III.

TEMPERATURE CHARTS OF RABBITS.

KLEBS & TOMMASI-CRUDELI.

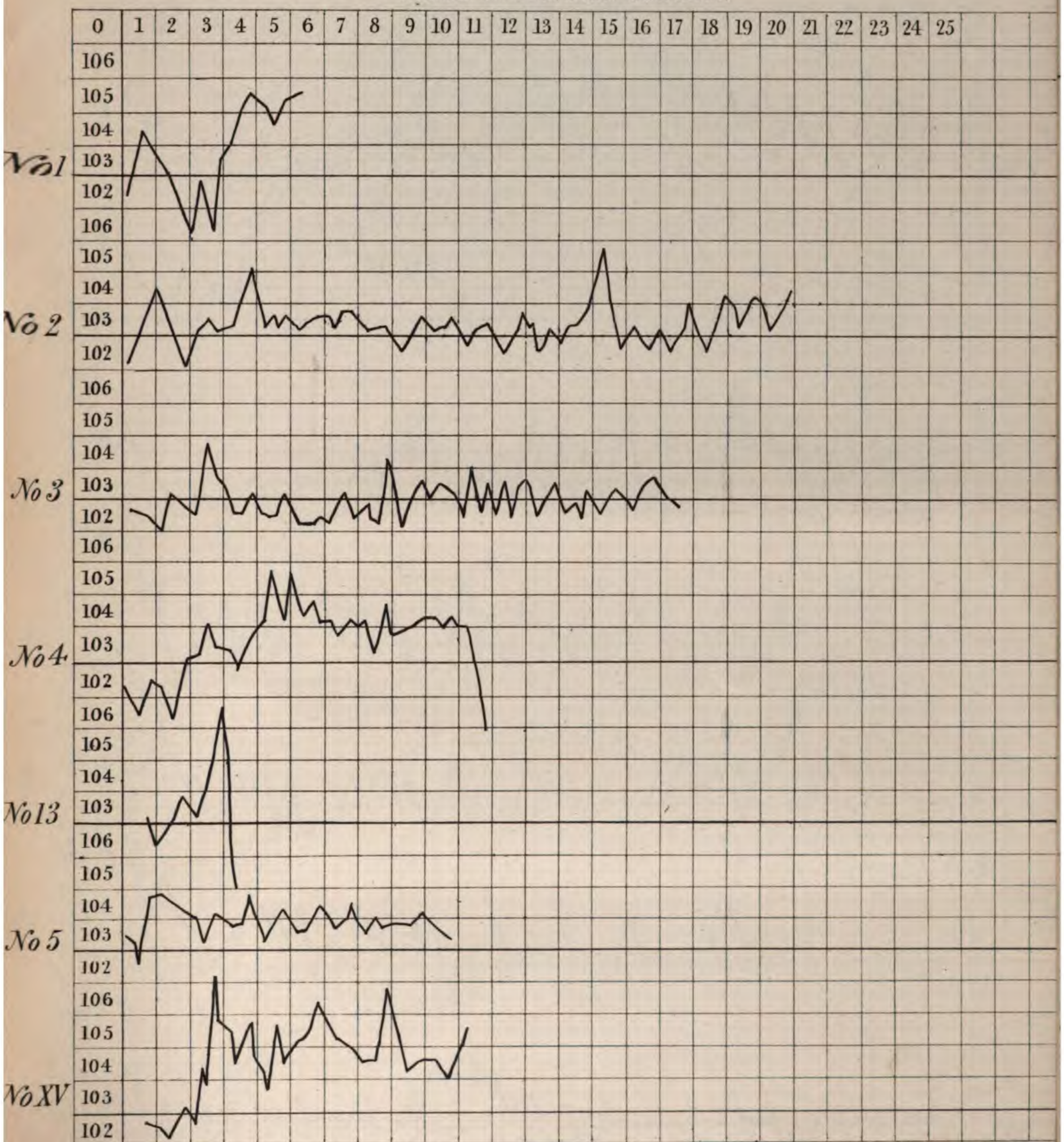
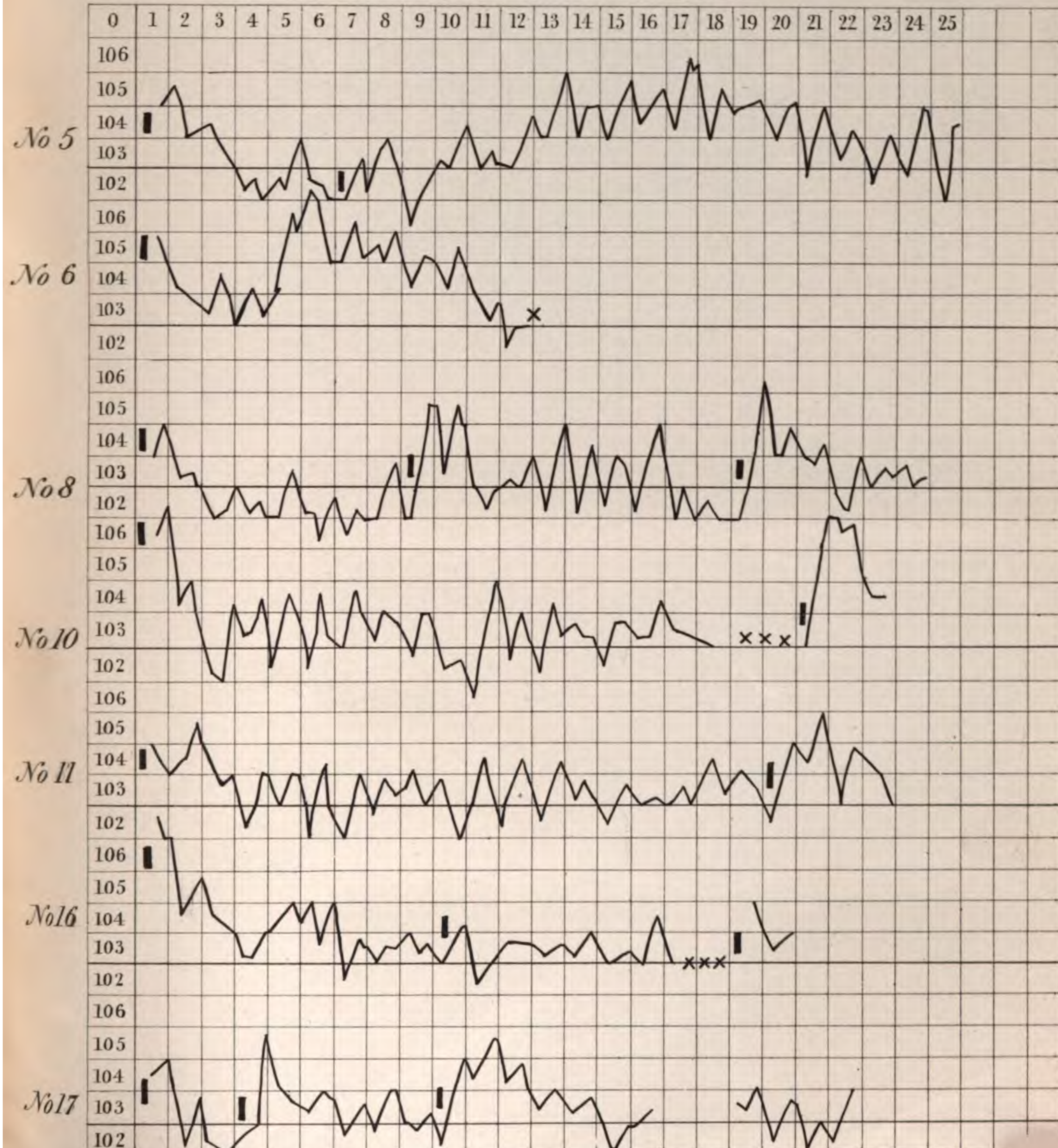


Plate IV.

TEMPERATURE CHARTS OF RABBITS.

DR STERNBERG'S EXPERIMENTS.



SUPPLEMENT No. 15,
National Board of Health Bulletin.

WASHINGTON, D. C., SATURDAY, NOVEMRER 19, 1881.

REPORT, RIVER INSPECTION SERVICE, 1881.

OFFICE OF THE SUPERINTENDENT,
RIVER INSPECTION SERVICE, N. B. H.,
Memphis, Tenn., October 15, 1881.

SIR: In accordance with telegraphed instructions from the Secretary, April 26, the Mississippi River inspection service of the National Board of Health was resumed for the season of 1881, by the assignment, on May 1, of Inspector S. H. Collins to duty at Vicksburg, Miss., and of Inspector W. B. Winn at Memphis, Tenn., under the rules and regulations of the previous season. The stations at Bayou Sara, La., and Cairo, Ills., were not included in these instructions, and nothing in the health conditions of the valley occurred during the season to warrant their re-establishment. Inspections were at first ordered to be continued until June 30 only, but this was subsequently modified so as to continue until September 30.

During this period, beginning May 1st and closing September 30, a total of 1,203 craft of all descriptions, carrying 42,401 persons—passengers, officers, and crews—were inspected at the Vicksburg and Memphis stations, being an increase of inspection at these stations of 373 vessels and 5,621 persons, as compared with the season of 1880. Following is a detailed tabular statement of inspections:

Tabular statement of inspections.

Inspections.	At Memphis.	At Vicksburg.	Total.
Passenger and freight packets	149	142	291
Officers and crew on same	9,089	9,230	18,319
Passengers on same	10,977	9,372	20,349
Towboats	61	53	114
Officers and crew on same	1,997	1,736	3,733
Barges, flatboats, &c	427	371	798
Total	22,700	20,904	43,604
Tonnage:			
Passenger and freight packets	141,822 67	202,026 24	343,848 91
Towboats	27,442 11	23,929 83	51,371 94
Barges, flatboats, &c	316,074 47	234,574 83	550,649 30
Total tonnage inspected	485,339 25	460,530 90	945,870 15

RESULTS OF INSPECTIONS—SANITARY CONDITION OF BOATS—HEALTH OF PERSONS.

Although at the beginning of the season the inspections disclosed some defects in the sanitary condition of vessels, there was found a marked improvement in this respect as compared with their condition at the opening of the previous season. It is evident that the work of the service in this direction is permanent. There is a continuous attention now paid, throughout the entire year, to the cleansing and purification of holds and bilges, to the policing of deck-rooms, crews' quarters, water-closets, &c., and to the general sanitary policing of the vessel. With the exception of an occasional admonition concerning a foul bilge (only two instances reported), the compulsory destruction of one lot of filthy deck-hands' bedding, and one dirty crews' water-closet, ordered cleansed and disinfected, there was found nothing objectionable in the condition of any of the regular passenger and freight packets. Three towboats required the bilge pumped out and holds disinfected, and six barges passed up with decomposing grain under the dunnage and in the limbers. All reasonable effort, however, seemed to be made to comply with the requests of the inspectors, and every facility was afforded by the officers for securing thorough inspections. Occasional instances occurred (eleven in all) in which boats cleared from New Orleans without notifying the inspectors at that port, and, consequently, without being inspected; and in which both barges and inhabited flatboats were added to tows in that port after the inspector had completed his inspection and furnished his certificate. In all such cases a thorough primary inspection was made on arrival at the first station (Vicksburg), and the facts were duly noted on the certificate. No boat is believed to have passed beyond the Vicksburg station the condition of which, either in persons on board, cargo, or belongings, offered any menace to the public health.

The morbility figures do not vary materially from those of the previous season, when 118 cases of sickness were found among the 82,045 persons inspected at New Orleans, Bayou Sara, Vicksburg, and Memphis, being in the ratio of 1.44 per thousand. This season 61 cases were found among 42,401 persons inspected at Vicksburg and Memphis only, a proportion of 1.43 per thousand. The gravity of the cases, however, seems to have been greater in the latter than in the former year, since in 1880 no deaths were reported as coming within the purview of the service, while during the season just closed there were three deaths *en voyage* and two at the stations. Following is a table of the sickness reported, together with the number and causes of deaths:

Diseases.	Cases.
Malarial fevers, remittent and intermittent*	32
Malarial toxæmia	6
Congestive malarial fever†	5
Typhoid fever‡	2
Jaundice	1
Diarrhœa, acute	5
Diarrhœa, chronic	1
Dysentery	3
Cholera morbus	1
Cholera infantum	1
Consumption§	1
Laryngitis, chronic	1
Alcoholism	1
Unknown‖	1
Total	61

*One death from *remittent malarial fever* during voyage; body transshipped at Memphis for Louisville by rail.

†Two deaths from *congestive malarial fever*; one during voyage, buried on the river bank above Greenville, Miss.; one at Memphis inspection station, forty hours after reception; buried at the station.

‡One death from *typhoid fever* on sixth day after reception at Memphis station, buried at station.

§One death from *consumption* during the voyage, below Vicksburg, and body landed at that port.

‖"Unknown," one man missing from boat on arrival at Vicksburg station; reported to have been put ashore sick at Gretna, La., opposite New Orleans.

In addition to the foregoing there were found "on board" one corpse with certificate from the New Orleans inspector; cause of death, "entero-colitis;" one from Helena, Ark., with permit from Memphis board of health; cause of death, "dysentery;" and one from Walnut Bend, Ark., referred to Memphis board of health; cause of death not stated.

SICKNESS AT THE STATIONS.

Owing to the high stage of water in the Mississippi on the 1st of May it was found impracticable to establish the stations on shore in the localities previously occupied. Inspections were, therefore, made until May 17 from the wharf-boat at Vicksburg, and until May 25 at Fort Pickering for Memphis, during which periods the inspectors and employés were quartered on the hospital barges. On the above dates, respectively, the permanent stations were occupied, but the sites proved unhealthy, and neither station was free from sickness at any time during the season. Inspector Collins was first attacked at the Vicksburg station, and was relieved by Inspector Winn on the 7th of June, Collins being transferred to Memphis. His illness continuing, Dr. Collins resigned June 20, and was succeeded by Dr. H. S. Ashe, of Memphis, appointed inspector June 21. On the 28th June Dr. Winn was prostrated, and was removed to the city hospital at Vicksburg, Inspector Ashe being sent to fill his place, while the superintendent took charge of the Memphis station until the arrival of Dr. Fayette Dunlap, of Danville, Ky., appointed inspector July 1. Inspector Ashe, who had already contracted malarial fever at the Memphis station, was seized with congestive chills soon after his arrival at the Vicksburg station, and continued to suffer from intermittent malarial fever until so far incapacitated for duty, that he tendered his resignation on the 15th of August, to take effect on the 31st. August 15 he was relieved by the superintendent, who took charge of the Memphis station until the return, September 1, of Inspector Dunlap from below, the Vicksburg station on that date being placed in charge of Dr. Rudolph Matas, of New Orleans, appointed inspector August 24. No further changes were made during the remainder of the season, but Dr. Dunlap was attacked with malarial fever immediately upon his arrival at his home in Kentucky. The frequently-recurring disabilities of the inspectors at the Vicksburg stations caused a few days' suspension of inspections at that point during the latter part of July, but they were resumed August 1, and continued thereafter uninterruptedly until the close of the season.

Not a single employé altogether escaped illness at either station during some portion of the season—the sickness being almost exclusively confined to the malarial fevers.

THE SANITARY FLEET.

There have been added to the sanitary fleet since the close of last season three new hospital barges and one disinfecting barge. The hospital barges consist of substantially constructed hulls 72 feet long, 20 feet beam, and 3 feet depth of hold, with four-foot guards all around, making the available deck surface 28 x 80 feet, or 2,240 square feet. Upon this deck is a hospital ward 20 x 45 feet, with accommodations for twelve patients, giving to each 75 square feet of floor space and 900 cubic feet of air space. Though below the minimum air space for hospitals on shore, this is believed to be ample for these isolated wards, which are open on all sides and are ventilated by 10 inch openings at the floor and eaves, extending entirely around the ward, and by a four-foot skylight, with pivoted sash, running the full length of the room. In addition to these provisions are two ventilating shafts in each ward, extending from the hold through the roof, so arranged as to be operated by the heat from stoves (in suitable weather), and calculated to thoroughly ventilate the ward independently of other means. As a measure of precaution in the case of delirious patients all windows and doors are securely protected by heavy wire screens. The wards are furnished with iron-frame hospital-cots, woven-wire bottoms, 36-inch cotton-top mattresses, and all other necessary appliances. Provision is also made for the isolation of any desired number of beds without obstructing light or ventilation. At the forward end of each barge, on the port side, is the nurses' room, and on the larboard side is the kitchen, while at the stern, on the port side, are the dispensary and store-room, and on the larboard side are the bath-room and water-closet. The roof of the ward is protected from the sun by heavy canvas awnings, and similar protection is furnished for each side along the guards. A proper equipment of anchors, lines, pumps, hose, &c., is also furnished.

The disinfecting barge consists of a hull 16 x 48 feet, with 3 feet depth of hold. An attendants' room and store-room (combined) is situated forward, and the large iron disinfecting-tank, formerly carried on the steamer Benner, is located in the roofed space amidships. A suitable boiler for generating steam for this tank has also been provided. Commodious bunkers for the storage of coal, disinfectants, &c., occupy the hold.

The hospital hulk, J. W. Vanzant, has been brought down from Cairo, and is now moored with the rest of the fleet at Fort Pickering. This hulk has been thoroughly overhauled and repaired, and the framework for a large hospital ward and the necessary offices has been erected, ready for bulkheading and roofing. For the present the boat is being used for storage purposes.

The sanitary fleet now embraces—

One sanitary patrol steamer, the H. H. Benner;
Three steam launches, the Lookout, Picket, and Sentinel;
Three hospital barges;
One disinfecting barge; and
One sanitary store-boat, the J. W. Vanzant.

Upon this fleet is now stored all of the property of the National Board of Health in the Mississippi Valley north of New Orleans, except one hundred and fifty barrels of sulphur at Cairo, Ills., and certain articles at Jackson, Meridian, and Concordia, Miss., which were distributed to those places during the epidemic of 1879. At this date the sulphur is being stored in the basement of the custom-house at Cairo, through the courtesy of the Hon. George Fisher, surveyor of customs at that port, and the remaining articles, in accordance with the instructions of the executive committee, are being shipped to the sanitary fleet, for storage, under the supervision of Dr. Wirt Johnston, secretary of the Mississippi State board of health. A detailed report and inventory of the property now stored at Fort Pickering was forwarded to the Secretary's office on the 30th ultimo.

PUBLIC CONFIDENCE IN THE SERVICE.

Cause for congratulation is to be found in the substantial absence during the past season, of alarming rumors and consequent excitement, and interference with travel and traffic. The only occurrence worthy of mention in this connection was the sickness on a towboat which arrived at Memphis one Sunday afternoon in July. She had several cases of malarial fever on board, and had lost her second engineer from the same cause just before arriving at the inspection station below the city. The landing of this corpse for transshipment to Louisville, and of three of the sick men for hospital treatment, caused considerable gossip among the idlers on the levee and the street-corner quid nuncs; and before nightfall a well-developed "yellow-fever scare" threatened, which, however, was promptly arrested by the publication of the following official statement:

[OFFICIAL.]

MEMPHIS, *July* 11, 1881.

The towboat John A. Woods, which arrived at this port last evening, had four men on board sick with intermittent fever, and one convalescing from the same. One man died on Saturday night. This man, Thomas Kunkle, had been sick between five and six weeks. The history of the case and examination of the body point to remittent fever, without proper treatment and care, as the cause of death.

There is absolutely nothing in the case of this boat to warrant any suspicion of contagious disease. If there had been any doubt as to the nature of the sickness on board she would not have been allowed to pass the station at President Island. Her sanitary history is known and a matter of record during the entire trip.

Notwithstanding our confidence in the vigilance and competency of the inspectors below Vicksburg and at President's Island, the undersigned verified the certificate of inspection and its indorsements by personally boarding and examining this boat and her people as well as the dead body, after she was moored at the coal fleet above the city.

Any statements or representations conflicting with the above are false, and their circulation is mischievous if not malicious.

G. B. THORNTON, M. D.,
President Board of Health.
F. W. REILLY, M. D.,
Superintendent River Inspection Service,
National Board of Health.

Of course, there have been some rumors and an occasional telegram, stating that yellow fever was reported at such-and-such a place, and asking particulars. The reply from the superintendent's office to such queries has, in every case, been accepted as conclusive; and it is believed that the various communities in the valley place the most implicit confidence in the vigilance and efficiency of the river inspection service.

Cordial co-operation and assistance have been extended to the service and its officers by the health and municipal authorities along the river, as well as by the various State boards of health. This is also true, with hardly an exception, of the masters and other officers of boats upon the river. These have, as a rule, evinced a cheerful desire to comply with the requirements and regulations, and have readily accepted and acted upon the suggestions or advice of the inspectors. Substantial appreciation of the service has been especially manifested by the management of the various Anchor lines of packets of the Saint Louis & Mississippi Valley Transportation Company, and of the Brown & Jones Coal Companies, which organizations have in many ways facilitated the work of the service.

The labors and responsibilities of the superintendent have been materially lightened by the counsel and advice of the resident member of the board at Memphis, Dr. R. W. Mitchell, to whom the existence and success of the river inspection service are so largely due.

I have the honor to be, sir, very respectfully, your obedient servant,

F. W. REILLY, M. D.,
Superintendent River Inspection Service.

DR. THOS. J. TURNER, U. S. N.,
Secretary National Board of Health, Washington, D. C.

REPORT OF STANFORD E. CHAILLÉ, M. D., SUPERVISING INSPECTOR NATIONAL BOARD OF HEALTH.

OFFICE OF THE SUPERVISING INSPECTOR AT NEW ORLEANS OF THE NATIONAL BOARD OF HEALTH,
New Orleans, La., October 12, 1881.

DR. T. J. TURNER,
Secretary National Board of Health:

SIR: Experience has amply proved that New Orleans is preeminently liable to receive and to disseminate the infection of yellow fever, and, since this city is the fifth port in the United States in respect to the amount of its shipping, and probably unsurpassed in the number of its river-craft, it is of great importance in reference to all portable diseases. For these reasons, I have entered into the consideration of more numerous details and at greater length than would otherwise have been deemed desirable in such a report as the one now respectfully submitted.

Appointed March 3, 1881, and assigned to duty April 26, my general instructions, dated April 28, were received May 2, and published for the information of the public May 4. Before considering these instructions, with the measures adopted for their execution and the results thereof, it is necessary, for their appreciation, to record the official history of sanitary matters in New Orleans for a few months prior to the issue of these instructions. This historical record will also throw light on the questions which has given rise to differences of opinion in regard to the administration of sanitary affairs in the State of Louisiana.

The following three questions may be thus stated:

First. Shall suspicious cases of yellow fever be promptly reported to the exposed neighboring States, or shall all suspicions be suppressed until the State board has given official assurance of the unquestionable existence of yellow fever; and, as an indispensable sequence of this question, this secondary question follows: Shall other States be permitted by Louisiana to have a representative, acceptable to themselves located in New Orleans, and provided by the State an-

thorities with every attainable facility to procure the information necessary for him, promptly to warn those whom he represents of threatened danger, thereby enabling them to adopt such measures of self-protection as they may see fit?

Second. Shall other States be permitted by Louisiana to have their own representatives, to give them timely information of both present and future risks of infection, located not only in New Orleans, but also at those State quarantine stations which are the danger outposts of adjacent States as well as of New Orleans?

Third. Ought Louisiana, regardless of the reasonable fears and expressed wishes of neighboring States, to persist in allowing *infected* vessels to enter the Mississippi River, thereby endangering many vessels and persons before said vessels have been disinfected at the Ship Island quarantine station provided by the National Board of Health as a refuge for all such vessels destined to any of its adjacent ports?

I.—Historical record from September, 1880, to April 28, 1881.

In respect to the public notification of the existence of yellow fever in New Orleans, the Louisiana State board has pledged itself several times in such terms as it did on September 23, 1880, when it was "*Resolved*, That as this board has *solemnly pledged itself to promptly* communicate to the country the existence, within our city and State of *any* epidemic or contagious diseases, it requests the press of the United States not to attach any evidence to any report in relation to the public health of our city or State that does not bear the official sanction of this board."

It is not believed that history can furnish a single instance in which similar pledges, by the authorities of any habitually infected place, have ever had the effect above requested or have ever secured the confidence of adjacent communities, occasionally but not habitually infected. In this instance there was ample evidence that the neighbors of New Orleans would not be satisfied with anything less than an agent located in New Orleans, to represent them there, and by timely warning enable them to protect themselves from its infection. On December 9 and 10, 1880, the "Sanitary Council of the Mississippi Valley," then in annual session at New Orleans, gave to this view the following expression:

"Whereas our people habitually view with distrust all announcements and sanitary acts of local boards, when those acts and announcements are of a character to affect the commercial interests of the locality directly concerned. *Resolved*, &c., &c.

"And whereas there is unfortunately a want of confidence with regard to the prompt furnishing of information by the health authorities of New Orleans with reference to infectious and contagious diseases:

"Therefore,

"*Resolved*, That in the opinion of this council, it would undoubtedly tend to the restoration of confidence if the State board of health would request the National Board of Health to place an inspector at the quarantine station and one in New Orleans, who shall have access to the records of the board of health, and be furnished every facility for obtaining reliable information with regard to all cases deemed suspicious and especially with regard to yellow fever."

This action of the sanitary council was vehemently denounced at the meeting of the State board on February 10, 1881, and great indignation was expressed in reference to an inspector or representative in New Orleans of the National Board of Health, with such privileges as are referred to in the above resolution, and to his assignment to duty as a so-called "spy" upon the board and its members.

On February 19, Dr. Cabell, president National Board of Health, wrote to the president of the State board inquiring whether said board would accede to two propositions, both as above, viz, the assignment to duty by the National Board of Health of an agent in New Orleans and of an inspector at the Mississippi River quarantine station, with adequate facilities for the discharge of their duties (see Appendix 1). This official letter of inquiry was not submitted to the State board until March 10, the date of its first regular monthly meeting after the receipt of said letter. In the mean time the executive committee of the New Orleans Auxiliary Sanitary Association adopted, on February 26, the following resolutions:

"Whereas the Sanitary Council of the Mississippi Valley, composed of the members of the boards of health and of the sanitary officers of the States and municipalities adjacent to and in closest relations with New Orleans, has requested the Louisiana State board of health to invite a representative of the National Board of Health to attend all the meetings of the said Louisiana State board of health, and to have free access to all its sources of information concerning the sanitary condition of New Orleans and its vicinity during the season of danger from yellow fever, and another representative to be stationed at the Mississippi River quarantine station during the same period and with similar privileges; and

"Whereas it is evident that only by compliance with this request that unreasonable apprehensions of danger can be anticipated, and premature and unnecessary restrictions upon commercial and personal intercourse with New Orleans be prevented; and

"Whereas large allowance should be made by New Orleans for the easily-excited fears of those communities whose protection against yellow fever is supposed to depend to a considerable extent upon early and accurate information concerning its appearance and progress in this city and neighborhood, and that every rational concession should be made to secure their confidence and good will.

"*Resolved*, That the Louisiana State board of health be urgently requested to reconsider their late action in regard to this question, and to acquiesce in what has been asked by the sanitary council of the Mississippi Valley."

A lengthy debate on the resolutions followed. Mr. Edward Booth opposed the resolutions, he being a member of the State board of health. Messrs. Charles A. Whitney, Joseph Bowling, Henry Ginder, George Horter, Charles Clinton, and Edward Fenner, spoke in favor of their adoption. The resolutions were adopted, Mr. Booth being the only vote in the negative.

Mr. Henry Ginder offered the following resolution, which was adopted:

"*Resolved*, That the New Orleans Auxiliary Sanitary Association, in behalf of the commercial and moneyed interests of the city of New Orleans, do hereby request the State board of health of Louisiana to call a special meeting of their board at as early a date as will permit their action on the resolution passed at the regular meeting of the executive committee of the New Orleans Auxiliary Sanitary Association, held February 26, 1881, to be presented to the convention of the Sanitary Council of the Mississippi Valley on March 11, 1881" [or, as it should have been, April 21, 1881].

The above resolutions, first published on February 27, were republished in the newspapers of March 13, with the signatures thereto appended of some eight hundred of the most respectable firms and citizens of New Orleans.

On March 10, previous to the republication of the above resolutions with their influential indorsement, the State board adopted, in response to the brief and simple propositions of President Cabell, and of the Auxiliary Sanitary Association, the lengthy replies cited in Appendix 2. To these eight whereases, four resolutions, and four propositions, the president of the State board added, on March 22, an open letter to the president of the New Orleans Auxiliary Sanitary Association, which letter occupied four columns of fine print in a daily newspaper.

The following points in said letter deserve recording: Respecting an agent in New Orleans of the National Board of Health "the board of health of the State of Louisiana has never denied free access to all its sources of information concerning the sanitary condition of New Orleans during the season of danger from yellow fever, nor during any other season of the year." "No board of so-called experts, and no member, agent, or employé of the National Board of Health can have any legal, or exclusive, or even constructive right to investigate the cases of the licensed practitioners of medicine." "The board of health has held that, before announcing to the world the first case or cases of yellow fever, the subject should be investigated and discussed, and that the annunciation of the existence of so decided a pestilence as yellow fever should be based upon undisputable facts."*

Respecting an inspector of the National Board of Health at the Mississippi River quarantine station, it was held that the present agitation of the questions relating to quarantine during the winter and spring months "will tend to excite alarm and distrust in surrounding States, and may lead to the arbitrary establishment of quarantine against New Orleans, without any just cause, at an early period of the summer." And the favor requested was objected to, because such an inspector would have no "power for good" and because "the National Board offers no substantial aid, but simply desires to be admitted at the quarantine station as an *investigator and judge* of the mode in which the legally constituted authorities of Louisiana perform their duties." On the above two subjects no passages have been found more definite than those cited.

Finally, the letter of President Jones opposes at length the proposition that infected vessels should not be permitted to enter the Mississippi River until they have been thoroughly disinfected at the Ship Island quarantine station of the National Board of Health. This proposition was first made by the National Board to the Louisiana State board on April 10, 1880, was promptly rejected, and in the annual report for 1880 of the latter board was severely denounced as one of "the preposterous schemes of the National Board of Health." This letter and the action of the State board, cited in Appendix 2, gave rise to much public dissatisfaction, as shown by the following evidence: On March 29, the official journal of the State, the Democrat, declared that Dr. Jones's letter was "an evasion of the issue;" that his view that the State board "possesses the confidence of the people at large" was "a delusion" of Dr. Jones alone; and that inasmuch as "we must make up our minds to the presence of the National Board of Health in the

*The present generation in the Mississippi Valley is not likely to forget that while in 1878 there was not a certified death by yellow fever in New Orleans until July 21, yet that there had been unreported suspicious cases and deaths during the preceding three weeks at least, and that the towboat John D. Porter, which left New Orleans as early as July 18, had on board 26 cases and 14 deaths by yellow fever between said city and Gallipolis, Ohio. The great additional devastation attributed to this boat was registered by Port Gibson and Vicksburg, Miss., by Hickman, Ky., and by Gallipolis, Ohio. This sad incident is only one of many others which teach the lesson that *prompt warning* should be given *even of suspicious cases* to at least those sanitary authorities interested. The ethics of all civilized nations now adopt as an axiom the principle that, in a conflict between public health and commerce, precedence must be given the former.

persons of its inspectors and other representatives, shall we have relations of candor, good feeling, and courtesy with them, or shall we, by a policy of jealousy, churlishness, and general folly force them into an attitude of distrust and antagonism?" And the people were advised to request the president and his supporting majority of the board to resign.

Further, on April 2, the New Orleans Auxiliary Sanitary Association having failed in its appeal of February 26, to the State board, adopted an address to the governor of Louisiana (see Appendix 3), appealing to him for the exercise of his superior authority to grant the two requests made by the Sanitary Council of the Mississippi Valley as formulated more definitely in the letter of February 19, of the president of the National Board of Health (see Appendix 1). It was urged that the State board should "revise its former action and grant, *without reservation*, the reasonable requests which have been made." This address to the governor stated: "You must have observed, if you carefully read the four closely-printed columns over the signature of the president of the board of health, that the plain and reasonable requests made by the Sanitary Council of the Mississippi Valley, and the other organizations already mentioned [the New Orleans Chamber of Commerce and the Medical and Surgical Association] have been carefully evaded, the generous and catholic spirit of the board of health paraded in glowing colors, and imaginary legal difficulties made to assume insuperable proportions. For the purpose of aiding the board in the solution of these grave legal questions, we have taken the liberty to submit the same to several distinguished members of the New Orleans bar, and have the pleasure of herewith appending their replies." These replies were all to the effect that the legal difficulties were "imaginary," and they were signed by all, it is believed, to whom the questions were submitted, viz: by one ex-associate justice of the United States Supreme Court, by three ex-associate justices of the Louisiana supreme court, by one ex-Senator of the United States, by two other lawyers of the highest local reputation. (See Appendix 3.)

At the two succeeding meetings of the State board, the following resolutions were adopted: On April 14, it was "*Resolved*, That this board concurs in the opinion of some of the river States that the National Board would do well to commence its river and railroad inspections on or about the 1st of May; and that this board cordially indorses the invitation, already extended by its president, to such inspector or inspectors as may be commissioned by the National Board of Health to occupy the commodious room adjacent to, and in communication with, the rooms and offices of this board at the State capitol; and that the inspector or inspectors aforesaid are requested and urged to be present as auditors and spectators at the meetings of this board, with a view to give efficiency to the wishes of the National Board of Health, expressed through its president, Dr. Cabell, under date of February 19, viz: 'That it may have adequate facilities for obtaining the information necessary to enable its inspectors to furnish positive and trustworthy certificates.'" At its next meeting, on April 19, the State board adopted the three following important resolutions:

"In order to allay apprehension in the public mind in the city and surrounding country, and to secure a correct report of the first case or cases of yellow fever which may occur in this city or within the jurisdiction of the State board of health—

"*Be it resolved*, That an agent of the National Board, to be stationed in New Orleans, shall have access to the daily reports received by the State board, and of sickness when reports of sickness are made; and that, whenever the agent of the National Board, or the health authorities of this State receive information of the alleged existence of one or more cases of disease of a doubtful or suspicious character as to its being infectious, the State board agrees to send one of its officers, who, together with the agent of the National Board shall investigate the case, the two parties reporting the results to their respective boards. In case the two parties disagree, a third physician, acceptable to the two parties shall be selected by them as umpire. A majority report shall be final and reported as such to the National Board in cipher. The two inspectors, as appointed, should have thorough knowledge of all diseases of the lower Mississippi Valley, and especially of yellow fever, and should be personably acceptable to the board, in order to secure friendly relations and useful co-operation, and it shall be the duty of said local inspectors of the National Board of Health to be present at all meetings of the local board.

"*Be it further resolved*, That the president of this board be requested to transmit a copy of these resolutions to the president of the National Board, and to the president of the sanitary council of the Mississippi Valley."

It was also on April 19—

"*Resolved*, That this board is of opinion that it is without power to nominate or appoint any Mississippi quarantine station inspector, whatever, and refers the matter of such nomination and appointment to his excellency the governor."

On this last subject, it is observable in Appendix 1, which contains all the official correspondence on the subject, that there never was any question as to the "nomination and appointment" of an inspector of the National Board of Health by either the State board or the governor, but the question was simply whether the National Board of Health would be permitted to station at the Mississippi River quarantine its own nominee and appointee "for purposes of observation and inquiry," and with "the privilege of inspecting in company with the [State] quarantine officer all vessels arising at the station."* Appendix 1, shows further that, acting on the above resolution, the president of the National Board of Health applied directly to the governor of Louisiana in May 17, and called his attention thereto; that Dr. S. M. Bemiss, resident member of the National Board of Health again solicited the governor's attention to the same subject on May 26, and, finally, that the application first made to the State board on February 19th, did not receive a favorable answer until June 4.

In the mean time the Sanitary Council of the Mississippi Valley held its annual session on April 21, and adopted among other resolutions the four following, bearing directly on the subjects now under consideration:

"*Resolved*, That the experience of the past teachers that the quarantine of that [the gulf] coast, and especially that on the lower Mississippi, cannot be relied on to prevent the introduction of yellow fever into the valley of the Mississippi, and that therefore immediate measures should be taken to so improve their management that all the resources of science and of human skill should be applied to prevent another invasion of yellow fever through that channel.

"*Resolved*, That the Sanitary Council of the Mississippi Valley reaffirm the action taken at its December [1880] meeting in New Orleans, and demands that the Louisiana board of health invite the appointment and maintenance by the National Board of Health of inspectors at New Orleans, at Port Eads, and at the Mississippi quarantine station, and announces that in the event of any failure on the part of the said State board of Louisiana to act in good faith toward said inspectors, the boards of health represented in this council will be compelled to take into their own hands the protection of the health of their own people.

"*Resolved*, That this council being firmly convinced that the safety of New Orleans, as well as of the valley, lies in the rigid exclusion of infected ships from the lower Mississippi, strenuously urges upon the State board of health of Louisiana a modification of 'section 6' of its rules and regulations for the government of quarantine officers and stations, &c., so as to read: SEC. 6. All vessels from ports in which yellow fever is prevailing or from ports where contagious or infectious diseases are reported to exist, shall be inspected at Port Eads. If any such be found to be infected, or furnish reasonable ground for suspicion of infection, such vessels shall not be allowed to pass Port Eads northwise except upon presentation of a certificate of inspection from the Ship Island quarantine station of the National Board of Health setting forth that the vessel has been subjected to the proper treatment, and is free from liability of conveying contagion.†

"*Resolved*, That this council condemns all methods of suppression and secrecy with reference to information of contagious or infectious diseases, therefore discountenances the use of cipher telegrams. But, in the event of danger from such diseases at any point in the Mississippi Valley, it is the duty of the executive officer of the health organization of such place to fully and promptly advise the proper authorities at all the threatened points."

On June 9, the State board vehemently protested against the above action of the sanitary council.

Having concluded the historical record of those official events which served as a preface to my duties, and to my general instructions, these and their results can now be duly appreciated.

II.—GENERAL INSTRUCTIONS OF APRIL 28, 1881.

These instructions, of which a copy is appended as Appendix 4 to this report, appointed me the "representative and chief executive agent in New Orleans" of the National Board of Health, with the title of supervising inspector. They required, in the first place, as my primary duty, "to obtain the earliest possible information of the existence of yellow fever in New Orleans or its vicinity;" in the next place, to secure between New Orleans and other points whether the former should or should not be free from infection, as uninterrupted commercial intercourse as the protection of the latter from infection might render practicable; and, in the last place, "in case of the appearance of yellow fever in New Orleans to co-operate in every way to limit the spread of the disease and to stamp it out if possible." These three duties require consideration, however, little will be needed concerning the last two, since no yellow fever infection appeared, either to be stamped out or to interrupt commerce.

OBTAINING INFORMATION OF THE EXISTENCE OF YELLOW FEVER.

To accomplish this duty, indispensable to the validity of my own river and railroad sanitary certificates and to the protection both of

* Hence, this was the proposition really rejected for lack of power, and yet on a subsequent occasion, September 15, 1881, and in a different issue, the president of the State board cited the various laws of Louisiana, which sustained the opinion of the lawyers consulted by the *Auxiliary Sanitary Association*, and in proof that "the board of health was placed *absolutely* and *unconditionally* by the general assembly of the State of Louisiana in charge of the Mississippi quarantine station and of all others within the limits of the State." (See Appendix 8.)

† The regulation of the Louisiana State board did, and does still read as follows: "SEC. 6. All vessels from ports in which yellow fever is prevailing, or from ports where other contagious or infectious diseases are reported to exist, shall be detained at quarantine stations for observation, disinfection, purification, and fumigation, not less than seventy-two hours, or for such length of time as the board of health may determine."

public health and commerce, the adoption of three measures was directed. First, the reception of reports from an inspector of the National Board of Health, at the Mississippi River quarantine station; second, prompt information from the State board of all cases of yellow fever and suspicious cases of fever; third, the same from all other sanitary and medical organizations, as also from physicians individually.

Reports from the quarantine inspector were not received until June 5, as his assignment to duty was not authorized by Louisiana until June 4, for reasons already stated and to be found in Appendix 1. Since June 5 the required reports have been received.

In order to secure prompt information of all cases of yellow fever and suspicious cases of fever, I was instructed to present to the State board the following proposition: "That all reports of deaths and the original returns made by the attending physician, of doubtful and suspicious cases, made to the Louisiana State board or to any member thereof, shall be communicated to you at once, whether they may have been formally presented to a meeting of the State board and entered on its files or not, and that if any of these cases shall appear to you to be of a sufficiently doubtful or suspicious character to demand it, you will, upon notifying the proper officer of the State board, be permitted to investigate the case in connection with such person or persons as may be appointed to accompany you by the State board." This important proposition was on May 19 unanimously adopted by the Louisiana State board (see Appendix 5). In connection with this proposition, the State board was solicited to agree that in the event of a difference of opinion in the diagnosis of doubtful cases of yellow fever between the agents of the National and State boards together with any umpire they might select, the different opinions should be reported to both boards and not the opinion solely of the majority. This proposition was not agreed to, as may be seen in Appendix 5. However, prior to the unanimous vote on this proposition, the representative of the National Board of Health stated that he wished it distinctly understood that he should obey his instructions and in all cases report his own opinion; but he would at the same time very willingly report any opinion differing from his own, whether said opinion was that of a majority or a minority. Having made this point clearly understood, the subsequent adoption of the first proposition was regarded as practically conceding the point at issue. It is, none the less, evident that the failure of the State board to agree distinctly to this second proposition may hereafter give rise to dissension.

As an additional means of securing prompt information of all cases of yellow fever or suspicious cases of fever, I was instructed "to endeavor to secure the co-operation of other sanitary and medical organizations" than the State board, and also of "the physicians of New Orleans, and of the river parishes below New Orleans." In order to execute this duty, a circular requesting the aforesaid co-operation, was read before the State board, was not objected to, and was issued on May 24 (see Appendix 6). This circular was directed to organizations and physicians in New Orleans, and to physicians residing in the river parishes below New Orleans, in parishes on the Texas Railroad, and for the most part in the vicinity of the Atchafalaya quarantine station, and in the counties of Mississippi traversed by the railroad to Mobile. It was distributed to the following places in the following number, and written answers promising the solicited co-operation were received from the number stated.

Locality.	Number of circulars distributed.	Number of favorable answers.
New Orleans	226	84
Saint Bernard & Plaquemine Parishes, between New Orleans and Port Eads	11	7
La Fourche and Saint Mary Parishes, between New Orleans and Texas	19	15
Gulf Coast of Mississippi, between New Orleans and Mobile	16	12
Totals	272	118

It deserves notice that while three-fourths of the country physicians promised co-operation, less than one-third of those residing in the city returned favorable written replies. This was probably due, in large measure, to the following causes: Some physicians believe that yellow fever originates here spontaneously, and that present sanitary organizations cannot prevent its occurrence; some are inimical to the National Board, some to all boards of health; and some are influenced by a considerable fraction of the community, which from interest or other motive opposes all quarantine or other restrictions on commerce.

The failure of so large a proportion of the physicians of New Orleans to promise their co-operation with the representative of the National Board of Health would not have been a cause for anxiety, provided that all were in the habit of reporting to the State board of health, as required by an ordinance of the city which the president of the State board very commendably distributed on May 1 to those whom it concerns. This ordinance is as follows: "All practitioners of medicine, masters of any water-craft, hotel, boarding or lodging house keepers, principals or masters of any public or private school, the chief officer or persons in charge of any public institution of charity or of punishment, and heads of families are hereby required to report, within twenty-four hours, to the office of the board of health all cases within their cognizance of Asiatic cholera, leprosy, yellow fever, typhus or ship fever, diphtheria, malignant scarlet fever, small pox, varioloid, trichiniasis, or any other case that may at any time be specified by the board of health." It is well known, however, that this ordinance is not obeyed by all, not even by all physicians, hence the effort to secure information additional to that promised by the State board, and hence the failure of so many city physicians to promise this information constituted a cause for serious anxiety, that the first cases of yellow fever might occur without the knowledge of any sanitary officers. Among the favorable answers from city physicians many were very gratifying, since they expressed hearty approval and cordial co-operation. One respondent, a creole physician, of long experience and repute, replied that his aid would be actively given for the sufficient reason, and apart from those urged in my circular, that he deemed it a crime to permit unacclimated strangers to visit this city without warning, when there were any cases of yellow fever here.

As an additional means of securing early information of the first cases of yellow fever in New Orleans and its vicinity, letters were addressed to United States collectors of customs, requesting them to notify me promptly of the arrival of any vessels reported to have suspicious sickness on board. Favorable answers were promptly received from all to whom the request was made, viz: from General A. S. Badger, collector of the port of New Orleans, to whom the collectors not only at New Orleans but also at Port Eads, at Southwest Pass, at Pass à l'Outre, at the Mississippi River quarantine station, at the Rigolets and at Lookout, a few miles beyond, all report; from Mr. J. R. Jolly, collector of customs at Morgan City, to whom also report not only the vessels arriving at the Atchafalaya quarantine station, but also at other places along the south coast of Louisiana,* and from Mr. J. R. Henderson, collector of customs at Shieldsborough or Bay Saint Louis, Mississippi, to whom also report all vessels arriving at Ship Island and other places along the Gulf coast of the State of Mississippi.†

All of these measures for securing prompt information were in practical operation by June 5, when the inspector of the National Board of Health arrived at the Mississippi River quarantine station. From this date great confidence was felt, notwithstanding the fear that some of the first cases of the dreaded fever might occur in New Orleans without the knowledge of any sanitary officers; yet, that the disease could not make such progress as to seriously endanger other States without my knowledge and their consequent warning.

An additional measure for securing information deserves notice. On April 14 the State board resolved that the inspector or inspectors of the National Board "were requested and urged to be present as auditors and spectators at the meetings of this board;" and it further resolved, on April 19, that "it shall be the duty of said local inspector of the National Board of Health to be present at *all meetings* of the local board." On this subject I was instructed "to use my own discretion in the matter." My discretion prompted me to attend on three occasions only. On two of these occasions I was treated personally with great courtesy, and given officially every desirable privilege. On the third occasion, an executive session on August 3, I was not permitted by the State board to exercise my discretion, and I have since been officially informed "that the board has decided that no one except those belonging to its own organization can be admitted to its executive sessions." It was my discretion to attend said executive session, because I had good reason to believe that it was to be held for the express purpose of determining an issue with the National Board; and the above decision of the State board was given in answer specially to my question, whether the privilege would be allowed me of attending those executive sessions, which might be called specially to consider subjects in which the National Board was directly involved. I had hoped that, by explanations in my power alone to give, I might, if present, be enabled to promote harmony between both boards, and I had no other motive.

In concluding this subject of the attendance of your representative in the meetings of the State board, it may be well to say that the chief aid desired of the State by the National Board is prompt information of the earliest cases of yellow fever or of suspicious cases of fever, and that this is not likely to be any better secured by attendance on said meetings, for the president has repeatedly promised that he would give such information. If your representative had the assurance that he would be granted the privilege of a voice on all occasions, when questions clearly involving the duties and interests of the National Board were under discussion, then his attendance on such occasions would, no doubt, tend to prevent useless misunderstandings, to inspire mutual respect for honest differences of opinion, and to promote the harmony so very desirable.

*Calcasieu Pass and Cameron. †Pascagoula, Pearlington, Pass Christian, &c.

ISOLATION, DISINFECTION, ETC., FOR STAMPING OUT YELLOW FEVER.

In respect to the first cases or suspected cases of yellow fever I was also instructed "to co-operate in every way with the health authorities of the city" in stamping out the disease if possible, and in order to accomplish this, "to secure isolation, systematic disinfection, &c." Fortunately I was spared this duty, and fortunately for my relief from anxiety my responsibility in this matter would have been subordinate to that of the State board. However, for the benefit of the future, the following facts should be understood: In the first place, it is all-important that the very earliest cases, however slightly sick, should be promptly reported to and taken in hand by the sanitary officers; these requirements are very liable not to be fulfilled. In the next place, efficient isolation and disinfection of families and houses must in this country depend, in large measure, upon the willingness of the afflicted families and of their friends to give their co-operation, and also upon public sentiment respecting the value of these measures. Until sanitary officers can obtain these supports, in perfecting all measures for isolation and disinfection, their frequent failure must be expected and prove their execution faulty rather than that the measures themselves are valueless, as is too often inferred. These impediments to success tend to render laws the best in theory very inefficient in practice. Our law is the city ordinance No. 6046, of July 8, 1879, and it reads: "The board of health may, at its discretion, regulate or *prevent access to or egress from*, or cause to be vacated, any infected building, water-craft, place, or locality; or cause to be fumigated, or otherwise disinfected, any infected building or water-craft whenever, in the opinion of said board, such action shall be deemed necessary to prevent the spread of *any* dangerous and infectious diseases." And, "the board of health may disinfect any infected clothing, bedding, or other substances whenever, in the discretion of said board, such action shall be deemed necessary to prevent the spread of disease."

SHIP ISLAND QUARANTINE.

On this subject, my general instructions directed me "to endeavor to secure the co-operation of the Louisiana State board of health" in obtaining the result, "considered highly desirable by the National Board of Health, that infected ships should be as far as possible excluded from the Mississippi River." The measures by which it was proposed to secure this result were those recommended on April 21 by the Sanitary Council of the Mississippi Valley, and already cited in this report. The action taken by me to fulfill my instructions and the unsuccessful issue thereof are fully recorded in Appendix 5.

The principle that "infected ships should be as far as possible excluded from the Mississippi River is so unquestionably sound, that it has been advocated even by Dr. J. Jones, the ablest, most persistent, and most influential opponent of the measure proposed for its execution. Dr. Jones, who became president of the Louisiana State board, April 8, 1880, urged, in February, 1879, as follows: "Quarantine should not only command all the outlets and inlets to New Orleans, but *all vessels from infected ports* should be *entirely excluded*, or else the cargoes should be landed at the quarantine station, and should be thoroughly fumigated and then transferred to lighters to be transmitted to the city. Upon no consideration should *a vessel from an infected port* be allowed to come up to the port of New Orleans." "An imperfect quarantine, such as now exists [1878–'9] at the outlets of the Mississippi, has been and will be a sham and delusion. The question of the foreign and domestic origin of yellow fever should be determined by an *absolute* quarantine."*

In addition to the facts presented in Appendix 5, the following bear upon the extent of the commercial interests involved in the question at issue. During the five years, 1876–1880, the average annual arrivals in the Mississippi River was 1,103 vessels, and of these the annual average number detained at the quarantine station was 153. This last average represents the number of vessels from at least May 1 to November 1 from all ports infected and even suspected of infection. The number of these 153 vessels, arriving really infected, so far as sanitarians could determine, has not, for years past, exceeded six; there was in 1880 none, or one at the utmost, the Excelsior, and in 1881 only two, the insignificant barks España and Cristina, which combined were only about 1,000 tonnage.

No doubt is entertained that New Orleans, and therefore its neighbors, would lessen the number of annual risks of infection, if such infected vessels were forbidden to enter the Mississippi River, and were forced first to proceed to the refuge for them at Ship Island. If this policy were once established and due notice given thereof, two good results would at once follow: First, infected vessels, bound for New Orleans, would sail direct for Ship Island, whereby most of them would avoid the 90 miles detour from Port Eads to Ship Island; second, all vessels bound to New Orleans from infected ports would be forced, by pecuniary interest, to adopt all the sanitary precautions calculated to protect them from infection, whereby the number of arrivals of infected vessels would soon be much diminished.

In order to secure the important information, so difficult to obtain, as to what vessels from infected ports are really infected, captains and crews cannot be at all trusted, nor, as a rule, either local board of health or United States consuls. Trustworthy sanitary officers, stationed at infected ports, are indispensable. Dr. D. M. Burgess, sanitary inspector at Havana, has well illustrated the usefulness of his service. But the import trade of New Orleans from the constantly infected ports of Rio and Vera Cruz is much more important than that of Havana, and New Orleans has the right to expect that it should be as well protected by the National Board from the dangers of the latter ports as from those of Havana. In case the Ship Island policy should ever be established, sanitary inspectors at foreign ports would not only aid in detecting what vessels *were* infected, but would also warn those bound for New Orleans that they must first proceed to the refuge provided for them at said island.

If the policy advocated respecting the national quarantine station at Ship Island is calculated to diminish the risks of infection, how much more important than in the past becomes the adoption of this policy for the future. New Orleans is now rejoicing in its prospects of unprecedented prosperity. The annual increase in the density of its population, in the number of its unacclimated inhabitants, and in the extent of its commerce with infected ports must constantly increase the risks and dangers of its own infection; while at the same time the increasing commerce of the Mississippi River and the greatly increasing facilities for rapid railroad communication with every part of our continent will increase, *pari pasu*, the risks and dangers of distributing this infection.

Having reviewed the chief points of my general instructions, consideration will now be given more especially to the sanitary work done.

III.—The inspection service of 1881.

When assigned to duty on April 26, authority was given to appoint two sanitary inspectors and two sanitary policemen for the river service. Drs. P. B. McCutchon and F. W. Parham were appointed inspectors on April 27, and assigned to duty on May 1; the two sanitary policemen, though selected, were held in abeyance for assignment to duty until need for their service should arise, which need did not occur.

On May 20 Drs. L. F. Salomon, J. M. Watkins, and P. S. Carrington were appointed inspectors for the railroad service, one for each of our three railroads, viz, the "Chicago, Saint Louis & New Orleans," the "Louisville & Nashville" (via Mobile), and the "Louisiana & Texas."

The agents of these roads, Mr. J. C. Clark, Mr. J. T. Harahan, and Messrs. C. A. Whitney and A. C. Hutchinson, responded in the most cordial and generous manner to the solicitation, to defray the expenses of these inspections, avowed their determination to support the National Board of Health, their perfect confidence in its local agents, and their willingness to be guided in the matter entirely by Dr. S. M. Bemiss, resident member, and Dr. S. E. Chaillé, the local agent and representative of the National Board. Restricting themselves to the single objection that they hoped the expense would not be imposed until Drs. B. and C. deemed it necessary, it was decided by them and subsequently approved by the National Board that the railroad service should not be inaugurated until the occurrence of one of two contingencies, viz, either the existence of yellow fever in New Orleans or the demand of communities on the route of the railroads. Since yellow fever did not occur, and since no communities on the aforesaid routes requested railroad inspections, except the Tennessee State board of health, the railroad service was not inaugurated except in compliance with said request. This was received on August 16, and on the 17th Drs. Salomon and Watkins were on duty for the two roads which traverse Tennessee. There have been no inspections on the Louisiana & Texas Railroad.

On June 4 the consent of His Excellency L. A. Wiltz, governor of Louisiana, to station an inspector of the National Board of Health at the Mississippi River quarantine station was received, and on June 5 Dr. G. F. Patton, who had been previously appointed, was assigned to duty, arriving at his post on the same day. On July 1 the steam-launch Lookout, which at my request had been transferred from Cairo to New Orleans on June 17, was forwarded to the Mississippi quarantine station. Its constant service has been indispensable to Inspector Patton, and has required two employés, viz, an engineer and a fireman, at a total expense of about $100 per month.

The employment of a clerk having been found indispensable, Dr. William Martin, who served as an inspector of the National Board of Health both in 1879 and 1880, consented to accept the position, has been on duty since May 20, and has rendered valuable service both to the resident member of the board and to myself.

The above completes the list of all officers and employés in the service of the board at New Orleans and its vicinity from April 26 to October 1, 1881. All were retired from active service on September 30 with the exception of myself and clerk, who were authorized to continue on duty, if the closing of the service and the completion of official reports should require it, to October 15.

The total expense to October 1 was $5,516.13, and will not equal to October 15 $6,000, of which about $1,800 were expended for the quarantine service. It is not believed that the service in New Orleans can, even in the healthiest years, ever be discharged in a manner satisfactory to adjacent States with a less numerous corps or at less expense. In fact, if the expense for three railroad inspectors from May to October is to be borne, as I think it should be, by the United States, if the quarantine service is to begin May 1 instead of June 5,

* See p. 616, vol. VI, new series, New Orleans Medical and Surgical Journal.

as it did this year, and if the necessary office-rooms are to be paid for, as was not required this year, then the least annual expense would fall little short of $10,000. This would, of course, be much increased in yellow-fever years.

For the posts which were filled there were three times as many applicants as offices. In making appointments preference was given to those applicants who had already served most satisfactorily, and who were acceptable both to the resident member of the National Board and to the president of the State board.

It was very difficult to fill suitably the inspectorship at the Mississippi River quarantine station. The location of this post is not agreeable, the occupant is deprived socially and professionally of all advantages, its responsibilities are very burdensome, and its opportunities for dissension and exposure to unfavorable criticism numerous. This post specially demands integrity, capacity, firmness of character, quarantine experience, and a reputation commanding professional and public confidence. These requisites for fitness are difficult to find even among physicians advanced in life, none of whom, if really suitable for the place, are likely to accept it for the salary paid. Only three physicians whom I was willing to appoint were found, and these consented to accept with reluctance. The names of these three were submitted to the president of the State board and subsequently to the resident physician at the Mississippi River quarantine station, who is under the law of Louisiana an appointee not of the State board, but of the governor. Both of these officers, while admitting that all three of the nominees were good men, expressed a decided preference for Dr. G. F. Patton, formerly in the service of the State at the same station, who was thereupon very gladly given the appointment. He has discharged his disagreeable and responsible duties to my satisfaction, and deserves special consideration. (See Appendix 7.)

To him and to every officer reporting to me cordial thanks are due for zealous co-operation. Each discharged not simply the regular duty assigned him, but has proved his willingness to do anything whatever deemed by me likely to promote the general good of the service. No officer could desire a better corps of subordinates.

While the inspection service required during the present year, extraordinarily because totally exempt from yellow fever, only six officers and three employés, I was, upon early application therefor, authorized to appoint, in case it should be deemed necessary, not only two sanitary policemen for the river service, as already mentioned, but also three additional inspectors for the three railroads, additional to the three first authorized; two for the two "basins" or city harbors of the two canals to Lake Pontchartrain, by which during the past year 3,335 vessels, averaging about 26½ tons each, entered the very heart of this city; and two inspectors, with four sanitary policemen, for such service in disinfection and isolation as the development of cases of yellow fever might render necessary. Thus, had yellow fever occurred, there had been selected and would have been on duty fourteen sanitary inspectors and six sanitary policemen, prepared to use every practicable means to protect adjacent States from infection by New Orleans, and to aid the State board in its contest against the infection in this city itself. It is believed that should a serious emergency arise not less than fifteen sanitary inspectors and an equal or greater number of sanitary policemen would find abundant occupation, and should be authorized.

From April 26 to date the supervising inspector has been uninterruptedly at his post, except on May 8, when, in company with Dr. Folsom, member of the National Board of Health, and with Dr. Jones, president of the State board, the Mississippi River quarantine station was inspected; and from May 13 to 16, during which time the river service, &c., at Memphis was inspected, in company with Drs. Folsom and Mitchell, members of the National Board of Health, and Dr. Reilly, superintendent of the river service above New Orleans.

Some consideration of the general facts concerning each service will now be given.

THE MISSISSIPPI RIVER QUARANTINE SERVICE.

During the present year the exceptional precaution was taken by the State board to detain and disinfect all vessels from Rio from March 1, a precaution due no doubt to last year's experience with the Excelsior. However, of the three gubernatorial proclamations, which were issued on the recommendation of the State board, the first was not published until April 22. This ordered the detention at quarantine for not less than three full days of all vessels from Rio, Havana, Vera Cruz, and Aspinwall; but the State board has the power, and exercises it, of adding any infected ports to those which may be proclaimed. The second proclamation, published June 16, extended after June 30 the existing three days' detention to ten days, and Aspinwall was omitted, in the absence of all evidence that it was infected. The third proclamation, published September 16, reduced after October 15 the ten days' detention to three days. Not only were vessels from the proclaimed ports quarantined, but also those from all Cuban ports, from Saint Thomas, and from the ports extending from Tampico to the Isthmus of Panama, thus including ports not probably infected, though suspected.

It deserves notice that the interval between the publication of the proclamations and the dates of their execution varied from only nine days to four weeks, an interval too brief for the interests of commerce. Also, that while a detention for less than ten days of vessels many days at sea would theoretically suffice, yet that ten full days' detention was probably a wise precaution, in view of the present impracticability of unloading, disinfecting, and reloading vessels with desirable thoroughness and promptness.

Other commendable precautions of the State board, which would have been more commendable if some had been earlier announced, deserve reporting. On July 7 it "*Resolved*, That any port in which an infectious disease is officially known to prevail shall be put among the proclaimed ports as soon as such information may come to the knowledge of this board."

On April 29 Dr. J. Holt, city sanitary inspector, was appointed "deputy inspector of shipping in the port of New Orleans," with the duties wisely established by the present board on April 22, 1880. Inspector Holt was also ordered that "the ships bringing cargoes of coffee must be fumigated at the wharf and a second fumigation must be performed in the warehouses receiving the coffee." On August 11 the city sanitary inspectors, six in number, "were required to visit all ships within their respective districts three times a week."

On August 30 public attention was called to a city ordinance of 1870, to the effect that "no case of disease shall be removed from any vessel in the port of New Orleans to any house, residence, or hospital in the city without a written permit from the president of the board of health, under a penalty of a fine of $50 for each and every offense."

As has been stated, the average annual number of vessels quarantined at the all-important Mississippi River station has, for the five past years, been 153. During the service of Inspector Patton there were 63 during the 111 days, June 5 to September 30.

The risks of foreign infection through the two other State quarantine stations, viz, the Rigolets of Lake Pontchartrain and the Atchafalaya station, near Morgan City, are remarkably few, as illustrated by the following facts: During the year ending August 31, 1881, there entered the port of New Orleans by the Rigolets from 1,300 to 1,800 schooners and steamboats, but of these there were only three from all foreign ports, and these three were all from Tuxpan, Mexico, and in August. But while the risks of introducing foreign infection are so slight, the risks of conveying infection from New Orleans to other States via the Rigolets, and to other ports of Louisiana via Lake Pontchartrain, would be very numerous; for during the aforesaid year there were from 1,300 to 1,800, for the most part dirty little schooners and steamboats, which cleared from New Orleans for the ports of other States, chiefly of Mississippi, Alabama, and Florida, and from 1,500 to 2,000 cleared for places in Louisiana on the north coast of Lake Pontchartrain. The average number of clearances during the months of danger was as great as during the balance of the year.

As to the Atchafalaya station, there entered Morgan City, or Brashear, during the year, 320 steamers and 85 schooners; of these there were none from foreign ports except steamers from Vera Cruz and the Mexican coast, and of these there were none from May to November, as they are habitually withdrawn during the quarantine.

As is well known, the practical difficulties of rendering *absolutely* perfect the quarantine of a great commercial port which has many avenues of entrance are at present insurmountable. The utmost which can be reasonably hoped for is to cut off an enormous proportion of the risks of infection. The Mississippi River quarantine does now, in my opinion, cut off a majority, perhaps even 90 or more out of 100 risks. During the past year it has been much improved, not only by the funds expended on it, but also by more rigid and better administration; and for this the present president and the State board deserve great credit. But it certainly has not yet become what it ought to be, as perfect as is practicable. Existing defects are sufficiently indicated in the official documents presented in Appendices 5, 7, and in the accompanying report of Inspector Patton. These defects are due in a measure to what may be termed inherited causes, and probably in greater measure to the very inadequate funds supplied by this State and city to the State board of health. So far as inherited causes are concerned, public opinion still continues so lax as to quarantine precautions that it much needs for its education additional epidemics or constant stimulation from without; this loose public opinion has fostered loose quarantine customs and acts. However good the will of the State board, it finds in these conditions very great obstacles to a perfect quarantine. Granting the will and all necessary laws, essentials must remain incomplete if adequate funds be not supplied. On this all-important point the State board furnished the following evidence on September 9. It appealed to the city council to give it, in addition to the $10,000 annually appropriated, $2,500 for the expenses indispensable for the balance of this year, stating that without this its inspectors and employés could not be paid; that $1,400 were now due, with only $400 cash in hand, and that "the financial condition of the board is worse than it has been for years." This is very poor encouragement to sanguine sanitarians; but while those living in neighboring and endangered States have a right to insist on the perfecting of all measures requisite for their own protection, they may none the less be reminded, in view of the $25,000 to $35,000 provided the State board by the impoverished treasury of this city and State, and in view of the impecunious condition of their own State boards generally, that

humanity in Louisiana as elsewhere sympathizes with her whom Christ protected from those about to "cast the first stone."

As fear has been entertained of the spreading of infection from the quarantine grounds to the adjacent neighborhood and as density of population is an important factor in solving the amount of the danger of infection, the following facts have been gathered with considerable labor and with, as is believed, closely approximative accuracy. The quarantine station, about 75 miles below New Orleans, is located on a very narrow strip of cleared land, only 1 to 1½ miles wide, between the Mississippi River and the Gulf of Mexico. It is about 30 miles above the Head of the Passes of the Mississippi and 38 above Port Eads. The population from 10 miles above the quarantine station to Port Eads, that is, of the lower 48 miles of the Mississippi River, is reported to be as follows:

	No. of inhabited houses.	White population.		Colored population.		Total.
		Males.	Females.	Males.	Females.	
East bank Mississippi within 10 miles above quarantine	85	148	138	80	90	456
West bank Mississippi within 10 miles above *Buras post-office	105	238	258	91	96	683
East bank from quarantine to Head of Passes	102	108	105	14	12	239
West bank from Buras post-fficeo to Head of Passes	50	192	201	44	38	475
Head of Passes, point, and both sides	......	27	26	....	....	53
Port Eads (South Pass)	......	116	15	9	8	148
Pilot Town (Southwest Pass)	......	150	50	6	3	209
Total	......	979	793	244	247	2,263

*The Buras post-office, directly opposite the quarantine station, is not, properly speaking, a village, the houses averaging at this part of the river, some 200 yards apart.

During the last month (September) of Inspector Patton's service certain charges, which have not been substantiated, have been made against him. The official correspondence and proceedings are recorded in Appendix 7. I have found Inspector Patton always trustworthy and obedient to his instructions, and I am confident that he would always comply with all regulations properly made known to him. It will be found in Appendix 7 that I have expressed my belief that the objections made to Inspector Patton are altogether secondary to the objections against having in future any inspector whomsoever of the National Board at the Mississippi River quarantine station.

His accompanying report contains additional facts of interest concerning specially the Mississippi River quarantine service.

THE RIVER SERVICE.

The annual reports of the New Orleans Price Current show that during the four years 1877-'80 the annual average of steamboats arriving at New Orleans slightly exceeded 3,000, and that the average for the five months, May to October, was 1,013. This year during the said five months there were only 203 steamboats and 208 barges inspected, for there were no orders to inspect any river craft except those which passed the Vicksburg and Memphis inspecting stations, and those steamboats (four only) which, after July 18, departed for Shreveport, the three places which have in recent years been ravaged so severely. No river craft other than those mentioned cleared from New Orleans for said places, nor for any places in other States via the Mississippi, with the exception of 8 steamboats and 9 barges which avoided the inspectors. During the first four months there were inspected 174 out of the 203 steamboats; however, the Price Current reports that during the same time there were 715 steamboat arrivals in New Orleans, indicating therefore the same approximate number of departures. It thus seems that not one-fourth of the steamboats from New Orleans pass above to Vicksburg or to other States. *This indicates farther the great additional work and responsibility which would probably be imposed on the river-service inspection if New Orleans should be again invaded by yellow fever, for in such case it is probable that all endangered communities would petition the National Board of Health, as Memphis, Vicksburg, and Shreveport have this year done, to inspect all river craft destined for the landings of said communities. In such emergency it would be necessary to inspect passengers as well as freight, and it is evident that two river-inspectors would not suffice for the service; for it should not be forgotten that a very great majority of steamboats leave New Orleans at 5 p. m., and that passengers board the boat during the last half hour. Hence, great difficulty would be incurred in effecting the thorough inspections necessary.

*Reliable assurance has been given that the steamboat statistics of the New Orleans Price Current are correct, but that they include the arrivals not only from the Upper Mississippi, but also from the Lower Mississippi and by Harvey's Canal, and at Milneburg, on Lake Pontchartrain.

There was manifested this season great cheerfulness on the part of the agents and officers of river-craft generally in voluntarily complying with the regulations of the National Board of Health, and there can be no doubt that the resulting good understanding and sanitary discipline has tended to effect results which would render the inspection service more efficient in time of real danger. As the inspectors are instructed to exercise no forcible measures, but simply to notify all departing river-craft which desire sanitary certificates that they can be procured by application therefor and undergoing the necessary inspection and compliance with orders, it is gratifying to report that out of 211 steamboats destined for Memphis, Vicksburg, and Shreveport only eight refused or failed to adopt the precautions necessary to procure the certificates. Even in seasons of danger there would be no means, here in New Orleans, to correct this evil, the responsibility for which rests with those communities which permit such recalcitrant river-craft to halt at their landings.

For details respecting the river service reference is respectfully made to the accompanying report of Inspectors McCutchon and Parham.

It will be as well to refer in this as in any other place to the canal service which would be desirable if New Orleans should become infected. Two canals from Lake Pontchartrain, namely, the Carondelet and the New Orleans Canals, penetrate into the very heart of the most densely-populated district of this city, terminating in the so-called Old Basin and New Basin, which are, the one within one-half mile, and the other in three-quarters of a mile of the bank of the Mississippi. During the year ending August 31, 1881, 3,335 small schooners and steamboats, averaging 26½ tons each, entered these basins, and a like number, of course, departed, destined for 16 different places on Lake Pontchartrain, and for 14 different places in the United States, chiefly in Mississippi, Alabama, and Florida, via the exit from the lake to the gulf, termed the Rigolets. A number exceeding the monthly average of the 3,335 vessels cleared during the five dangerous months, May to September. These facts sufficiently indicate the need for a canal-inspection service in case New Orleans should be infected; and, since the two basins are over a mile distant from each other, the service could not be performed, as is believed, by less than two inspectors and two sanitary policemen. In addition, steamboats leave Milneburg, a lake precinct of New Orleans, several times weekly for places both on the north shore of Lake Pontchartrain and on the Gulf coast of Mississippi, Alabama, and Florida. Still farther, New Orleans has a third canal, Harvey's, which has little commerce, on the west bank of the Mississippi, connecting this with the Gulf of Mexico.

THE RAILROAD SERVICE.

As has been stated, this service was not established this year until August 17, only then because solicited by the Tennessee State board of health, and it was applied only to freight trains, and not to passengers or passenger trains, on two of our three railroads. All freight cars were properly inspected, the regulations duly enforced and cheerfully complied with, and sanitary certificates given to every freight train. So far as I am informed, these certificates were never called for on the border of Tennessee or elsewhere on the route, and no officer was provided by the Tennessee State board of health, as one would suppose should have been the case, to examine carefully whether the sanitary condition of the trains justified the certificates given them. It is manifest that the efficiency of sanitary inspectors is not promoted by such a course.

If New Orleans were infected, every one of its three railroads would require not less than two inspectors, one for freight, the other for passenger trains. In 1880 there was also an inspector, paid by two of the three railroads, to accompany passenger trains; were this deemed necessary hereafter, then, in emergency, there would be required nine inspectors for the three present railroads. But it should not be forgotten that within a few years, even within one, the railroad communications of New Orleans will be much increased, and a corresponding increase of inspections be required.

For details respecting the railroad service reference is respectfully made to the accompanying reports of Inspectors Salomon and Watkins.

IV.—Consideration of several pertinent subjects.

EXEMPTION OF NEW ORLEANS FROM YELLOW FEVER IN 1881.

To this date not only no death by yellow fever has occurred, but no case, not only no case, but no suspicious case, and not only no suspicious case, but no alarming rumor of one. It is doubtful whether the same good fortune has ever occurred since 1796, when New Orleans was visited by its first epidemic of yellow fever. It is certain that during the past sixty years there has been but one year, 1861, without a recorded death by yellow fever, and in said year New Orleans was blockaded by the United States on May 28, and no vessels approached New Orleans by the Mississippi until April 25, 1862, when the city was captured by the United States Navy. However, there have been several years in which one or only two deaths have been recorded, and these generally occurred in imported cases. In addi-

tion to the absence of the disease this year from New Orleans, it was likewise totally absent at all three of the Louisiana quarantine stations. Two vessels arrived at the Mississippi River quarantine station which certainly had been infected when at Havana, but the rigid precautions enforced this year on all suspected vessels were strenuously applied to these two. Although in Havana yellow fever did not prevail at as early a date, nor later to as great extent as usual, which is believed to have been due to the lack of the usual number of unacclimated immigrants, yet the disease did prevail with severity at several other of the most important Cuban ports, and, of greater consequence to New Orleans, with unusual severity at Vera Cruz, owing probably to the large number of unacclimated immigrants attracted by the railroad enterprises inaugurated in Mexico. But for the quarantine restrictions on vessels from infected ports our quarantine stations, at least, would certainly not have escaped the importation of some cases.

Preceding facts tend to strengthen the view, now generally accepted, that yellow fever in New Orleans is an exotic and not an indigenous disease. This view, however, cannot yet be considered by science as fully and finally established. Therefore, it may be well to record, without discussion, other facts than those stated which bear upon the total exemption of this city in 1881 from yellow fever.

On the one hand, it is noteworthy that all places in the United States have this year escaped yellow fever, with the exception of a very few cases at its most southern port, Key West, and that, while yellow fever apparently flourishes best in humid climates and seasons, this season has been unusually dry.

On the other hand, the following facts deserve record: Local sanitation and quarantine restrictions have both been enforced more satisfactorily than usual at all yellow-fever ports except Key West, where these precautions continue to be at their minimum. Though this season has been unusually dry, yet the history of yellow fever records numerous instances of the concurrence of devastating epidemics with droughts destructive to agriculture; New Orleans was severely ravaged in 1841, yet the season was exceptionally dry. The heat this season has been unusually severe, especially during June, the month in which the first cases which precede an epidemic in New Orleans are most apt to occur. Farther, in spite of the valuable improvements in local sanitation, due in large measure to our sanitary association, it can scarcely be claimed that New Orleans was so clean this season that it had not filth enough to propagate yellow fever if present or to originate it if filth can originate it. On this subject a letter, published April 6, from the president of the State board, called attention to many instances of gross local insanitation, and further stated that "the city of New Orleans is at the present moment in the same filthy condition that it was in the spring of 1878, preceding the epidemic of yellow fever which inflicted such incalculable damage upon this city and neighboring towns and villages." Farther, not only did the noses of those exposed, but also the sanitary association, protest against the foul and stinking condition of our thirty-odd miles of very inefficient drainage canals, so that two of our three most influential daily papers denounced them vigorously in editorials on August 13. Not only were heat and filth amply supplied, but the high death-rate, indicative of danger, was also added thereto. For, although the death-rate for the entire season has been favorable, yet it exceeded 40 per 1,000 for the seven dangerous and anxious weeks from May 7 to June 25. Inasmuch as there was no unusual dryness until after this date, there seem to have been present in New Orleans, at the most favorable season for yellow fever, those conditions to which has been attributed the origin of this disease in other years. On the whole, while the evidence is not conclusive, it tends none the less to strengthen the belief that New Orleans owed its total exemption in 1881 from yellow fever to the protection provided the city, indirectly as well as directly, by its quarantine stations. Due credit should also be given for the favorable influence in protecting sea-going craft from infection ascribable to the publication June 28, 1879, and to the subsequent wide distribution by the National Board of its admirable "Rules and regulations for securing the best sanitary condition of vessels, including their cargoes, passengers, and crews, coming to the United States from any foreign port where any contagious or infectious disease exists."

The proof has been conclusive that New Orleans need not annually either import or originate yellow fever, and this proof is calculated to stimulate the increased efforts and precautions necessary to test whether the disease cannot be avoided every year.

GOOD ACCOMPLISHED BY THE NATIONAL BOARD OF HEALTH.

Granting that sanitary officers are the victims of the usual human infirmities, there can be no doubt that the two services, national and State, served to stimulate the vigilance and zeal the one of the other. Great confidence is felt and instances could be given to prove that the presence of the national inspectors, did tend to increase the efficiency of the State sanitary authorities in the discharge of their duties, and that good was done thereby.

Even unfounded rumors of yellow fever inflict much injury on New Orleans, if not promptly denied by those in whom perfect confidence is felt. Such confidence was felt and expressed in the local officers of the National Board of Health even by Memphis, which is now for good reason the city most easily alarmed as to yellow fever, that there, as everywhere else, rumors were promptly suppressed as soon as official assurance was given that they were groundless. My attention was called to not less than a dozen rumors or causes for rumors, for the most part early in the season. All these proved to be groundless, and when assurance was given not only of this, but also that information would be promptly given of any which might prove to be well founded, the rumor manufacturers, silly and timid rather than malicious people, abandoned their occupation before the season was half over. There can be no doubt that many persons within and many more without New Orleans bestowed great confidence on the National Board of Health, that great satisfaction was derived by them therefrom, and that much good was done.

The agents and officers of river craft and railroads were disciplined in sanitary inspections and precautions to an extent calculated better to prepare them for compliance with the more rigid discipline which would be indispensable in a season of danger for the protection of other communities. It is believed that much good was thus effected.

Finally, the presence of the officers of the National Board of Health with the avowed intention of reporting not only the truth, but the whole truth, and of hesitating at no measure within their power calculated to protect adjacent States, has tended undoubtedly to arouse discussion, to disseminate sanitary information among the people, and to stimulate them to sanitary progress. Much good has been and will be due to this.

Discussion is the parent of that harmony of opinion which leads to efficient action, from which comes progress. To one like myself, who seeks the evidence of human progress rather from generation to generation than from year to year, and who has an experience of thirty years in New Orleans, the evidences of sanitary progress are decidedly encouraging, and especially so since 1878. However, there still remain in our public opinion such diverse views about yellow fever that there is no one view which cannot gather in its defense a very positive and turbulent crowd, and therefore there is no one view or persistent course of action which could be adopted by the National Board, or any one else, that would give universal satisfaction and escape unfavorable criticism. It is believed that the time is approaching when New Orleans and other communities will become convinced that their best policy as to transmissible epidemic diseases is to let everything be known, and that they can by this means best protect themselves from the distrust which not only originates rumors, but also inflicts panics and other evils.

RECOMMENDATIONS.

As my recommendations have been called for, the following are respectfully submitted:

1. The funds and power which Congress may provide should be freely used in giving Louisiana the assistance much needed to perfect the quarantine stations on which the protection from yellow fever of the Mississippi Valley, as well as of New Orleans, greatly depends. If this were accomplished, their good administration secured, most of the many vessels from infected ports left to State quarantines for treatment, while the few known to be infected or suspected thereof for manifestly good reason were refused permission to enter the Mississippi unless they had been disinfected at Ship Island, then the United States would have done all in the way of quarantine precautions which an enlightened government ought to do to protect from yellow fever the Mississippi Valley. Farther, whatever the National Board may be enabled to do in order to aid and co-operate with the Louisiana State board in accomplishing the commendable ends which its president recommended on September 29, 1881, should be done. These recommendations were as follows:

"Justice to the commercial community demands that rigid rules as to the length of quarantine should be fixed by legislative enactments, and not be left to the fancies of boards of health changing perpetually with political revolutions, and sometimes actuated by motives of aggrandizement for relatives and political dependents.

"According to the existing laws of Louisiana the funds derived from quarantine should be legally devoted to its maintenance, and should not be diverted by the board of health to pay either the sanitary police or the sanitary inspectors, the salaries of whom, according to the legislative acts of 1870 and 1877, are directly chargeable to the city of New Orleans.

"An advance in the quarantine system of Louisiana would be effected by the thorough equipment of the Rigolets and the Atchafalaya stations, and by the construction of a capacious and well-ventilated floating hospital for the harbor of New Orleans, to which all contagious and infectious diseases occurring amongst the shipping should be immediately transferred. It is not right that cases of small-pox, typhus, and yellow fever should be carried from the shipping into the heart of a great city, as has been the case in former times (as was done in the case of the Excelsior in 1880). There is no remedy for this evil but the establishment and thorough equipment of a floating hospital (as provided by the National Board at Vicksburg and Memphis), and the employment of a competent physician, at a liberal salary, to take charge of it and to be on duty at all times.

This measure should be supplemented by the appointment or employment of a competent, experienced physician whose sole duty

should be the continuous inspection of the shipping and the prompt removal of all infectious diseases to the floating hospital."

2. The continuance of an inspector at the Mississippi River quarantine station is very important, and such an understanding with the State of Louisiana should be arrived at as might tend to render this assignment permanent, and if it were continuous throughout the year greater efficiency of said inspector's services would, it is believed, be better secured. No proper person can be found to accept this disagreeable post unless liberally paid, and quarters should be provided for him and his employees, either on the United States warehouse grounds, which are within those of the quarantine station, and are owned by the United States, or other suitable provision should be made.

3. The most valuable import trade of New Orleans is with habitually-infected Rio; its trade with Mexico, especially with habitually-infected Vera Cruz, is more valuable than with Cuba, and is likely to be greatly increased. For these reasons it is strongly recommended that a trustworthy sanitary inspector should be posted at Rio and at Vera Cruz, to render there the same valuable services now rendered by your inspector at Havana. A statistical table is presented in Appendix 9 in illustration not only of the above facts and of the foreign commerce of New Orleans with ports rarely, if ever, infected with yellow fever, and with ports frequently or habitually infected, but also of the destructive influence of an epidemic of yellow fever (1878) on this foreign commerce.

4. For thorough efficiency in times of danger from epidemic diseases it is as important to constantly maintain the permanent nucleus of a sanitary organization, with some officers always in service, as it is important to maintain an army and a navy in time of peace. However great present ignorance and opposition, civilization must ultimately arrive at the conviction that thoroughly organized effort is as necessary to conquer disease as other enemies. Notwithstanding the popular notion to the contrary, it is very certain that very few doctors are sanitarians, and that few sanitarians in this country have the practical experience indispensable to efficient execution. This cannot be secured except through practice and discipline in actual sanitary work. Reliance in time of danger upon such inexperienced physicians as can by chance be picked up at an insignificant and temporary monthly salary is little more than blindly trusting to chance, and the results are liable ultimately to bring unmerited condemnation on any board of health forced to resort to such untrustworthy expedients. It is, therefore, recommended that whatever can be done to perfect the organization of an experienced official corps of practical sanitarians should be done.

If forced to continue to resort to present expedients, then it is recommended that all such measures be adopted as are calculated to promote the nearest attainable approximation to an experienced, and and therefore permanent, corps of sanitary officers. For instance, such measures in New Orleans as follows:

The river and railroad services, as well as the quarantine service, should be instituted every year, whether healthy or not, from May 1 to October 1 at least. This I deem indispensable to secure not only the official experience, but also the cheerful and intelligent compliance of the public with the sanitary precautions necessary when danger does arise. This would now require not less than seven officers during healthy seasons.

It is in time of danger that disability would be most apt to occur, and also that not less than eight additional inspectors would be required; therefore, not only should the appointment (without pay until assigned to duty) of these fifteen inspectors be authorized long before danger arises, but authority should be given to select one alternate for every inspector, to supply his place in case of disability. Farther instructions should be given that, as far as practicable, the inspectors assigned to one service, as the river service, should be transferred to another service, as the railroad service, for such time as might be necessary for each one to familiarize himself with the practical work of both services. Still farther, inspectors reserved for emergency, and all alternates, should be instructed to familiarize themselves with their duties by attendance, for sufficient time, on the work of those inspectors who may be on duty; and in appointments preference should always be given to those who gave the best proof of compliance with these instructions.

It is believed that these measures could be carried out in New Orleans provided that it was understood that the members of the corps of inspectors proposed for temporary service in periods of danger should not be compelled to leave New Orleans; for no desirable man, unless in permanent and salaried service, is likely to consent to be ordered at any moment to abandon his home.

By the adoption of the above measures there would be provided for emergencies a corps of inspectors not totally inexperienced in their duties, and ready, as is so supremely important, to enter into the discharge of those duties without a day's delay.

5. Other recommendations have been suggested in the accompanying reports of my subordinate officers, to which attention is respectfully called.

CONCLUSION.

Your instructions "to counsel freely and fully" with Dr. S. M. Bemiss, resident member of your board, have been cheerfully complied with, and his invariable approval of my course has been a source of great satisfaction. In no instance has there been any difference of opinion, and in every instance I have received from him valuable information and advice. My cordial thanks are also due for the encouragement and support so liberally and heartily given me by the National Board of Health and its officers. To these evidences of satisfaction have been added proofs that the public was content, as it always is in prosperity, and that my course secured the decided approval of that enlightened faction of the people for whose approbation alone am I generally in any wise anxious.

Yours, very respectfully,

STANFORD E. CHAILLÉ,
Supervising Inspector.

APPENDIX 1.

Official correspondence concerning the assignment of an inspector of the National Board of Health to the Mississippi River quarantine station.

WASHINGTON, D. C., *February* 19, 1881.

Dr. JOSEPH JONES,
President State Board of Health of Louisiana:

SIR: I am directed by the executive committee of the National Board of Health to address a communication to you relative to the resumption by the board of the system of sanitary inspections at New Orleans of railroads and river craft which was put into operation last summer at the request of the State board of health of several of the Mississippi Valley States, including that of the State of Louisiana, as represented by yourself.

This board is willing to renew these inspections for the coming season, but before assuming the responsibility involved in such action it desires to know whether it will have adequate facilities for obtaining the information necessary to enable its inspectors to furnish positive and trustworthy certificates. To this end I am instructed to inquire whether the State board of health will accede to the following propositions:

1. That an inspector of the National Board be stationed at the Mississippi quarantine for purposes of observation and inquiry, who shall have the privilege of inspecting, in company with the quarantine officer, all vessels arriving at the station, and who in the event of a difference of opinion between himself and the quarantine officer as to the actual sanitary condition of such vessels, and in the treatment which they require, shall send to the president of the State board a copy of his report made to the National Board.

2. That an agent of the National Board to be stationed in New Orleans shall have access to the daily reports of deaths received by the State board and of sickness when reports of sickness are made, and that whenever either the agent of this board or the health authorities of the State receive information of the alleged existence of one or more cases of disease of a doubtful or suspicious character as to its being infectious, the State board agrees to send one of its officers, who, together with the agent of the National Board, shall investigate the case, the two parties reporting the result to their respective boards.

An early answer to these inquiries is respectfully requested.

Respectfully, yours,
J. L. CABELL,
President National Board of Health.

WASHINGTON, *May* 17, 1881.

Hon. L. A. WILTZ,
Governor of Louisiana, New Orleans:

SIR: I am instructed by the executive committee of the National Board of Health to invite your attention to a proposition submitted on behalf of the said board to the board of health of the State of Louisiana in a letter of February 19, a copy of which is herewith inclosed. In the published proceedings of the meeting of the State board consequent on the reception of this letter it is stated that the question relative to the placing an inspector of the National Board of Health would be referred to your excellency.* It is believed that no objection will be made on the part of the State board or of the quarantine officer, and that both are disposed to co-operate with the agent of the National Board in New Orleans in the discharge of the duties which have been assigned to him. I am also directed to say that the National Board desires to maintain at Eadsport an inspecting station with authority to prohibit the passage up the river of actually infected vessels until the same shall have undergone suitable and adequate disinfection at the Refuge at Ship Island. It is not proposed to apply these measures to any other than infected vessels, the proportion of which to the rest of the shipping is so small that there will be no serious interruption to commerce, while the chances of spreading the infection will be greatly diminished. An early reply is respectfully requested.

Very respectfully, your obedient servant,
J. L. CABELL,
President National Board of Health.

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*On April 19 the State board "Resolved, That this board is of opinion that it is without power to nominate or appoint any Mississippi quarantine station inspector whatever, and refers the matter of such nomination and appointment to his excellency the governor."

NEW ORLEANS, *May* 26, 1881.

HON. L. A. WILTZ,
Governor of Louisiana :

SIR: I respectfully ask your attention to the inclosed copy of a resolution passed by the State board of health of Louisiana at a meeting held April 19, 1881. As resident member of the National Board of Health, and in its behalf, I have the honor to inform you that the National Board deems it important to the public interests that the inspector therein referred to be assigned to duty at the quarantine station at an early date. I therefore respectfully request your assent to such assignment. An early reply is respectfully requested.

Very respectfully,

S. M. BEMISS,
Member National Board of Health.

EXECUTIVE DEPARTMENT, STATE OF LOUISIANA,
New Orleans, June 4th, 1881.

Dr. S. M. BEMISS,
Resident Member of National Board of Health :

DEAR SIR: I am directed by his excellency Governor Louis A. Wiltz to acknowledge his receipt of your letter of May 26th, 1881, calling his attention to the resolution of the State board of health, adopted April 19th, 1881, informing him that the National Board of Health deem it important to the public interests that the inspector therein referred to be assigned to duty at the quarantine station at an early day, and requesting his assent to such assignment. The governor directs me to state that the request of the National Board is complied with by him.

I have the honor to remain your obedient servant,

E. W. HALSEY,
Private Secretary.

APPENDIX 2.

Reply of the Louisiana State board of health to President Cabell.

OFFICE BOARD OF HEALTH,
STATE OF LOUISIANA,
New Orleans, March 15, 1881.

A communication from Dr. J. L. Cabell, president of the National Board of Health, under date of February 19, 1881, having been read at the meeting of the board of health of the State of Louisiana, at its meeting held March 10, Mr. Booth offered the following remarks and resolutions as hereunto annexed.

S. S. HERRICK, M. D.,
Secretary Board of Health.

In the matter of the communication from Dr. Cabell, president of the National Board of Health, this board receives it with the consideration which its source and its subject alike merit, and in the nature of an answer thereto beg to submit briefly the following views upon its polite requests and suggestions:

1. As to the resumption by the National Board of Health of the system of sanitary inspectors at New Orleans of railroad and river craft, as operated during last summer, &c., this board affirms its former position of cheerful consent thereto, and will co-operate in making these inspections as useful and as perfect as possible.

The board trusts that the several States of the Mississippi Valley will continue their adhesion and support to a work so desirable and important.

2. In the matter of facilities for obtaining information necessary to enable the inspectors of the National Board of Health to furnish positive and trustworthy certificates, this board can only repeat its assurances that every facility lawfully within its power, or accessible to its officers, shall be given. The pledge of the board, given by President Choppin, has been loyally redeemed, and continues to be the sincere determination of the present members. This board will hereafter, as heretofore, use every diligence to ascertain and communicate what is true with care and promptitude, and the National Board of Health may depend upon its agents receiving such assistance as is due them under the pledges of this board.

3. As to the proposition that there shall be an inspector of the National Board of Health stationed at the Mississippi quarantine for the purpose of observation and inquiry, who shall have the privilege of inspecting, in company with the quarantine officer, all vessels arriving at the station, and also, in the event of a difference of opinion between himself and the quarantine officer as to the actual sanitary condition of such vessels, and as to the treatment which they require, shall send to the president of the State board a copy of his report made to the National Board, it may be premised that it involves legal points which prevent this board from passing upon it without having been referred to its counsel or to the attorney-general of the State, to see by which, if any, authority this board could intervene in a matter not confided to it by law, that is, the nomination of officers at the Mississippi quarantine station.

Is is presumable that if this board is without authority for the proposed step, it is unnecessary to enter upon its merits.

The board is but frank in adding that it is not in doubt as to its position and limitations under existing laws, and is of opinion that it would be idle to seem to grant what it is powerless to enforce. Still the proposition will be referred as above, and the resulting opinions or actions promptly communicated.

4. The application that an agent of the National Board of Health representing it in New Orleans shall have access to the daily reports of deaths is a public right open to and enjoyed by all who please to take advantage of it, and the press continually keeps the public advised of the daily mortuary.

5. In the matter of reported sickness not mortuary there are no formal reports provided for, but when under certain conditions cases assume phases of doubt or suspicion as to their infectious character or tendency, this board follows the wise precedents of former boards in calling consultations with experienced physicians of high rank, who, together with the president of the board and its medical members, form a committee of experts to diagnose and decide upon the status of such cases as in any manner come under review.

It is believed that no plans so far proposed can be more likely to give correct results or be intrinsically better than that already in vogue, and this board has no objection to include among its invited experts any medical gentleman, agent, or representative of the National Board of Health who may be in New Orleans at the time when the board may deem it desirable for the ascertainment of facts to call in members of the profession in aid of the president and to guide the judgment of the board.

But in all cases the board recognizes the inalienable right of the physician in attendance to judge for himself and to give his certificate to the board on that judgment, and to this end he has the undoubted right to call in consultation with him whoever of the profession he may find convenient or agreeable to himself.

Wishing to meet every well-intended overture in a spirit of fairness and candor, this board has thus passed before it all the points found in the communication of the president of the National Board of Health, and hopes that the explanations made, pledges renewed, and information given will prove satisfactory. Therefore—

1. *Resolved*, That the propositions to place an inspector or agent of the National Board of Health at the Mississippi quarantine station be referred to the counsel of the board, who is hereby requested to confer with the attorney-general of the State as to the authority of this board to appoint or place an agent or inspector of the National Board of Health at the Mississippi quarantine station as proposed.

2. *Resolved*, That the foregoing and appended resolutions and views shall be taken as the response for the present of this board, and that the president be requested to communicate the same at early convenience to Dr. Cabell, president of the National Board of Health, with such prefatory or explanatory remarks as he may see necessary or deem useful to be made.

In conclusion, the board ask to append as part of this answer two resolutions passed at their regular monthly meeting, March 10, 1881. (See reply below to the Sanitary Association.)

OFFICE BOARD OF HEALTH,
STATE OF LOUISIANA,
New Orleans, March 15, 1881.

At a meeting held March 10 the following propositions were presented by the president, Dr. Jones, and received general assent:

1. The headquarters of the railroad and river inspection service to be at the board of health.

2. The State board reserves the right to nominate the inspectors from active, intelligent, and upright medical men.

3. The inspectors to have daily access to the death list, and also to the cases reported to the board of health demanding investigation.

4. All reports of inspectors to be furnished in duplicate to the State and National boards.

A true copy from the minutes.

S. S. HERRICK, M. D.,
Secretary Board of Health.

Reply of the Louisiana State board of health to the New Orleans Auxiliary Sanitary Association.

Whereas there has been laid before the board an extract from the minutes of the regular meeting of the executive committee of the New Orleans Auxiliary Sanitary Association, containing statements and resolutions adopted February 26, 1881, to the effect that "an agent or representative of the National Board of Health be seated at this board; also that an agent or inspector of the National Board of Health be stationed at the Mississippi quarantine station;" and

Whereas the latter of these propositions has already been suggested by the president of the National Board of Health, to which a response, with reasons therefor, has been made by this board, and considering that the former of these propositions, that is to say, the seating of an agent or representative of the National Board of Health at this board,

nvolves substantially the same question, and needs to be referred to counsel for advice before the board can take action thereon; and

Whereas it is the constant desire of this board to treat the expressed wishes of their fellow-citizens with the greatest respect: Therefore—

1. *Resolved*, That the subject-matter of said resolutions be referred to the counsel of the board for report, after conference with the attorney-general of the State as to the powers of the board to act in the premises; said report of counsel, when made, to be submitted to the board at its next succeeding meeting.

2. *Resolved*, That the president be requested to address an invitation to all State boards in contiguous or neighboring States, especially those of the Mississippi Valley, to be represented near this board at any time by accredited agents, to whom shall be cheerfully accorded every facility for examination and information upon all matters affecting the public health which may in any manner come to the knowledge of this board or its medical inspectors, and to whom the records of the office shall be open for examination, transcription, or study of any statistics deemed useful or of public interest. And, further, that they or any of them, or any agents or representatives of any other health organizations or boards, local or national, or any citizens not health officials, are invited to be present as spectators and auditors at the meetings of the board, as there is transacted at such meetings only public business, in which the people have an unquestioned right to participate according to law.

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APPENDIX 3.

Extracts from the proceedings of April 2, 1881, of the New Orleans Auxiliary Sanitary Association.

Mr. C. A. Whitney, president of the association, took the floor and said:

I beg to inform you that just prior to our last meeting I received a long communication from Dr. Joseph Jones, president of the State board of health, in relation to the resolutions adopted by this association, respectfully asking a reconsideration of their action relative to the admission at their meetings, for purposes of information only, of a representative of the National Board and a representative at the quarantine station on the Mississippi River. As the letter has been published and you are doubtless familiar with its contents, I simply submit it for your consideration. I do not know that anything further can be done by us; but, in order that a matter so important to the welfare of this community be not utterly abandoned, and for the purpose of making known the precise position of this association with reference to this subject, I have prepared an address, which I submit for your approval.

To his excellency Louis A. Wiltz, governor of the State; Hon. Joseph Shakspeare, mayor, and administrators; Thomas L. Airey, president of Cotton Exchange; E. K. Converse, president Produce Exchange; Cyrus Bussey, president Chamber of Commerce:

"At a meeting of the Auxiliary Sanitary Association, held on the 26th of February, the following preamble and resolutions, embodying substantially views previously expressed by the Sanitary Council of the Mississippi Valley, the Chamber of Commerce, and the New Orleans Medical and Surgical Association, were adopted, with but one dissenting vote, and were subsequently approved by the signatures of hundreds of the most prominent business and professional gentlemen of the city:

"'Whereas the sanitary council of the Mississippi Valley, composed of the members of the boards of health and of the sanitary officers of the States and municipalities adjacent to and in closest relations with New Orleans, has requested the Louisiana State board of health to invite a representative of the National Board of Health to attend all the meetings of the said Louisiana State board of health, and to have free access to all its sources of information concerning the sanitary condition of New Orleans and its vicinity during the season of danger from yellow fever, and another representative to be stationed at the Mississippi River quarantine station during the same period and with similar privileges; and

"'Whereas it is evident that only by compliance with this request that unreasonable apprehensions of danger can be anticipated, and premature and unnecessary restrictions upon commercial and personal intercourse with New Orleans be prevented; and

"'Whereas large allowance should be made by New Orleans for the easily excited fears of those communities whose protection against yellow fever is supposed to depend to a considerable extent upon early and accurate information concerning its appearance and progress in this city and neighborhood, and that every rational concession should be made to secure their confidence and good-will:

"'*Resolved*, That the Louisiana State board of health be urgently requested to reconsider its late action in regard to this question, and to acquiesce in what has been asked by the Sanitary Council of the Mississippi Valley.'

"In addition, because of the vital importance of the subject, and the long interval of more than four weeks between the regular meetings of the State board of health, the association passed a resolution politely asking the board of health to hold a special meeting for the consideration of the question. No response whatever was made to this request; nor did the board at its subsequent regular meeting take the slightest notice of the communication, not even so much as to acknowledge its receipt. However, at this same meeting of the State board, a letter of a similar character from the president of the National Board of Health, J. L. Cabell, M. D., LL. D., of Virginia, was read, and definite action upon its contents postponed for another month by a resolution referring certain unimportant legal technicalities to the attorney of the board and the attorney-general of the State.

"On the 26th of March, at 3 p. m., just one month after the action taken by the association, and only four hours previous to its regular weekly session, a package from the Louisiana State board of health was placed upon the office-table of the president of the association. The package was not opened until 6 p. m., when it was found to contain a communication from the president of the State board of health, dated five days before, March 21, and covering thirty-three pages of extra large foolscap paper, which, with the accompanying copies of letters, amounted to forty-four closely written pages. Owing to their great bulk, the documents could not be immediately read, and were not, therefore, transmitted to the meeting of the association, which was held an hour later. Notwithstanding this the communication was published by its author in one of the city newspapers the following morning, and was thus spread before the public in advance of an opportunity for its consideration by the association.

"You must have observed, if you carefully read the four closely-printed columns over the signature of the president of the board of health, that the plain and reasonable requests made by the Sanitary Council of the Mississippi Valley, and the other organizations already mentioned, have been carefully evaded, the generous and catholic spirit of the board of health paraded in glowing colors, and imaginary legal difficulties made to assume insuperable proportions. For the purpose of aiding the board in the solution of these grave legal questions, we have taken the liberty to submit the same to several distinguished members of the New Orleans bar, and have the pleasure of herewith appending their replies.

"It must be evident, however, to the most careless reader that the spirit and tone of the communication of the president of the Louisiana State board of health furnish no encouragement whatever to the idea that it may yet acquiesce in the simple and equitable demands which have been made upon it, notwithstanding the effort made to convince the public that the main points were granted long before they were raised. And what are these demands? At the risk of being a little tedious, we venture to state them again by quoting from the letter of Dr. Cabell, of the National Board of Health, which letter only repeats the requests made by the sanitary authorities of the State in closest relation with New Orleans:

"'1. That an inspector of the National Board be stationed at the Mississippi quarantine station for purposes of observation and inquiry, who shall have the privilege of inspecting, in company with the quarantine officer, all vessels arriving at the station, and who, in the event of a difference of opinion between himself and the quarantine officer as to the actual sanitary condition of such vessels and as to the treatment which they require, shall send to the president of the State board a copy of his report made to the National Board.

"'2. That an agent of the National Board, to be stationed in New Orleans, shall have access to the daily reports received by the State board, and of sickness when reports of sickness are made; and that whenever the agent of this board or the health authorities of the State receive information of the alleged existence of one or more cases of disease of a doubtful or suspicious character as to its being infectious, the State board agrees to send one of its officers, who, together with the agent of the National Board, shall investigate the case, the two parties reporting to their respective boards.'

"What can be more just or equitable to the numerous States of the valley of the Mississippi, which are by geographical position and commercial relations as deeply interested in the sanitary regulations of the outlets of the great river as the citizens of New Orleans themselves? No demand is made for any participation in the powers or authority of the State board; no discreditable reflection is made upon the dignity of this body, no slight is put upon a single one of its members. All that is asked is that the National Board of Health be granted equal opportunities for obtaining prompt and accurate information concerning sickness or suspected sickness of an infectious nature which may occur in or near New Orleans or upon the vessels which enter her waters and threaten to extend to neighboring States. We have no evidence that this has been acceded to, and the object of this address is to urge you to consider the serious results which are likely to follow. On the 20th of April the Sanitary Council of the Mississippi Valley, which, although a 'voluntary association,' is nevertheless an association of sanitary authorities, and thereby wields an immense power over the sanitary regulations of the States adjacent to the Mississippi River and its tributaries, will hold its annual session at Evansville, Ind. We are positively assured that at this meeting, unless the Louisiana State board of health shall in the mean time revise its former action, and grant without reservation the reasonable request which has been made, measures of self-protection will be recommended to the respective States, and New Orleans will in all probability be isolated during the whole ensuing summer by a most effective system of interior quarantine.

"We have no new suggestions to make as to how this impending calamity may be averted, but whatever is to be done should be done quickly. We, as an association, have performed our duty in the premises to the best of our knowledge and ability, and can now only make this our earnest appeal to your superior authority, and leave the matter entirely in your hands."

The following are the interrogatories propounded to Messrs. J. A. Campbell, R. H. Marr, H. C. Miller, W. W. Howe, E. D. White, J. B. Eustis, and Henry J. Leevy, attorney for the New Orleans Auxiliary Sanitary Association:

"1. Would the Louisiana State board of health violate any laws or exceed its authority by permitting a representative of the National Board of Health to be present at all its sessions from the month of May to that of November inclusive, to pledge itself and each of its members to give said representative immediate and full information concerning any suspected cases of yellow fever which may occur in or adjacent to the city during the period mentioned, and grant him equal oppo rtunity for examining such cases?

"2. Would the Louisiana State board of health violate any laws or exceed its authority by permitting a representative of the National Board of Health to reside, at the expense of the latter, from May to November, upon the grounds of the Mississippi River quarantine station, and by granting him equal facilities with those possessed by the quarantine physician for obtaining prompt and accurate information concerning the arrival and presence of all vessels and persons infected or suspected of infection by yellow fever?"

I know of no law which the Louisiana State board of health would violate, nor do I know in what respect the board would exceed its authority by permitting a representative of the National Board of Health to be present at all its sessions from the month of May to that of November, inclusive; to pledge itself and each of its members to give said representative immediate and full information concerning any suspected cases of yellow fever which may occur in or adjacent to the city during the period mentioned; and grant him equal opportunity for examining such cases.

I may add that there is a wide difference between that which the board may have *lawful* power and authority to do, and that which it is compelled by law to do; and that it might be necessary for the board to have occasional sessions, merely for the purpose of its general business and administration, at which the presence of any others than members of the board would be neither useful nor desirable.

To the second interrogatory I answer that I know of no law which the Louisiana State board of health would violate, nor do I know in what respect it would exceed its authority "by permitting a representative of the National Board of Health to reside, at the expense of the latter, from May to November, upon the grounds of the Mississippi River quarantine station, and by granting him equal facilities with those possessed by the quarantine physician for obtaining prompt and accurate information concerning the arrival and presence of all vessels and persons infected or suspected of infection by yellow fever."

R. H. MARR.

In answer to the two questions submitted by you, and upon which you request my opinion, I have the honor to state that the Louisana State board of health would not violate any law by permitting a member of the National Board of Health to be present at the sessions of the State board, or to reside at the quarantine station, for the purposes and under the conditions indicated in your questions.

J. B. EUSTIS.

I see nothing in the laws creating the board or governing quarantine which would render it illegal or impossible to grant the requests covered by the interrogatories stated.

E. D. WHITE.

The board of health is a body corporate, having an important function to perform for the State and clothed with powers of administration adequate to the performance of their public duties. Among these faculties are those for the management of their own affairs, and to prescribe rules for their own government.

Your first interrogatory is whether they are competent to authorize a representative of the National Board of Health to attend the sessions of their board; and to agree to communicate freely and unreservedly to that representative information which they may have relative to any suspected case of yellow fever which may occur within their jurisdiction, between the first day of May and the first day of November of each year, and to allow that representative to inspect or examine such cases. We understand the National Board of Health to have been established to perform in the neighborhood, functions analagous to those of the board of health of the State.

Both corporations are organized for a common purpose of promoting the general utility and protecting the health of the community.

We cannot discern any cause for excluding either board from any opportunity for obtaining exact and immediate information of all that is important for them to know.

That there has been no restriction upon the board of health of this State, and upon their authority to confer all that is contemplated in your question upon the representative of the National Board of Health, in our opinion, is indisputable.

Second. The board of health is established for the purpose of maintaining a quarantine system as essential to the security of the State. The members of the board must be zealous in its support to fulfil their obligation.

The board may employ nurses and assistants for the sick and other persons required to carry out quarantine duties, and to make all needful rules and regulations for the maintenance of quarantine, and the board may establish quarantine stations and make all needful rules and regulations with respect to them.

Your second question is whether any law would be violated by the permitting of a representative of the National Board of Health to reside upon the grounds of the Mississippi quarantine station, and granting to him all the facilities allowed to the resident physician for obtaining prompt and accurate information concerning the arrival and presence of all vessels and persons infected or suspected of infection by yellow fever.

We answer that they have full power to grant such permission at their discretion. We have examined the rules and regulations of the board of health, and find in the sections enumerating their powers (page 37) ample authority to them to do all which is contemplated to be done under either of your questions.

J. A. CAMPBELL.
W. W. HOWE.
HENRY C. MILLER.

I have carefully examined the statutes relating to the powers of the State board of health and fully concur in the above.

HENRY J. LEOVY,
Attorney for Auxiliary Sanitary Association.

Mr. Lyman said that as the representative of the sanitary association he had attended the meeting of the Sanitary Council of the Mississippi Valley, and he was struck with the manifest distrust with which the Louisiana State board of health was regarded, and the evident desire of the council to have a National Board of Health officer admitted to the meetings of the State board.

While in Saint Louis, a short time ago, he had been told by the president of the Illinois board of health, whom he happened to meet there, that unless a National Board of Health officer was put in position to obtain early and accurate information from the Louisiana State board of health, New Orleans was liable to be isolated.

He offered the following resolutions relative to the matter, which were adopted:

Resolved, That we approve and indorse the address prepared by the president of this association in relation to our recommendation to the State board of health to admit at their meetings, for purposes of information only, a representative of the National Board of Health, and for the same purpose a representative at the quarantine station on the Mississippi River, and that we accept as our own the statements and views therein expressed.

Resolved further, That the secretary be instructed to send copies of the address to his excellency the governor of the State, his honor the mayor of the city, and to the president of the board of health, the Cotton Exchange, the Chamber of Commerce, and the Produce Exchange.

APPENDIX 4.

General instructions of the National Board of Health to the supervising inspector at New Orleans.

NATIONAL BOARD OF HEALTH,
Washington, D. C., April 28, 1881.

Dr. S. E. CHAILLÉ,
Supervising Inspector, National Board of Health, New Orleans, La.:

SIR: I am directed by the executive committee of the National Board of Health to forward the following instructions for your guidançe during the coming summer. The object which the National Board of Health desires to secure through you are: First, to obtain the earliest possible information of the existence of yellow fever in New Orleans or its vicinity; second, to secure free commercial intercourse between New Orleans and other points so long as such intercourse is unattended with danger; third, when by reason of the existence of yellow fever in Louisiana, intercourse must be carried on with other States under certain restrictions to so arrange matters that these restrictions shall cause no more interference with commerce than is absolutely necessary; and fourth, in case of the appearance of yellow fever in New Orleans to co-operate in every way to limit the spread of the disease and to stamp it out if possible.

I inclose herewith for your information copies of certain municipal and State ordinances recently enacted (A), from which you will see that it is only upon your certificates, or upon the certificate of inspectors duly authorized by you, that boats from New Orleans will be allowed to land at the places in question during the coming summer. Your duties, therefore, have great importance, and involve a heavy responsibility, both in preventing danger to surrounding communities on the one hand and to prevent unnecessary interference with the commerce of New Orleans on the other.

The possibility of your being able to obtain the second object, by

1. *Suspicious cases of yellow fever.*—For sanitary purposes the following symptoms associated with a fever of one paroxysm, in a patient who has apparently been exposed to infection and has never had yellow fever, shall be held to justify (if occurring between May 1 and November 1) in either of the six following cases a suspicion of this disease, viz:

First. Suddenness of attack, either with violent pain in back and head, injected eyes and face, or with marked congestion of the superficial capillaries.

Second. Want of that correlation between pulse and temperature usual to other forms of fever.

Third. Albuminous urine.

Fourth. Black vomit.

Fifth. General hemorrhagic tendency.

Sixth. Yellowness of skin.

The following cases shall also be deemed suspicious:

Seventh. Any cases respecting which reputable and experienced physicians disagree as to whether the disease is or is not yellow fever.

Eighth. Any case respecting which efforts are made to conceal its existence, full history, and true nature, in violation of section 28, city ordinances of May 18, 1870, and section 22, city ordinances, June 24, 1879.

In the event of the death of a suspicious case a post-mortem examination should be made when practicable. Both before and after death yellow fever is specially and pre-eminently characterized by the fact that it is par excellence a hemorrhagic fever, marked by capillary congestion and its sequela; hence post-mortem evidences of a general hemorrhagic tendency in internal organs, especially in the digestive in preference to the urinary tract, shall be held to confirm the suspicion.

Appendix 5.

The following report of Dr. F. Formento was unanimously adopted on May 19, 1881, by the Louisiana State board as its reply to the propositions contained in the general instructions of April 28 of the National Board of Health, which propositions were submitted to the State board on May 13:

I have carefully examined and studied the communication made to this board at its last meeting, May 13, 1881, by Dr. Chaillé, supervising inspector of the National Board of Health, and I have given to the important subject laid before us all the consideration and attention it deserves.

This communication is of great interest. The propositions which it embodies are so varied in their character and purpose, the measures submitted for our approval and consent are so momentous, that body from which these proposals emanate is entitled to so much respect, that we deem it our duty to examine them seriatim, and at what will perhaps be considered too great a length.

Proposition No. 1 reads as follows: "That all reports of deaths and the original returns made by the attending physician of doubtful or suspicious cases of yellow fever to the Louisiana State board of health, or to any member thereof, shall be communicated to you (the supervising inspector) at once, whether they have been formally presented to a meeting of the State board and entered on its files or not, and that if any of these cases shall appear to you (the supervising inspector) to be of a sufficiently doubtful or suspicious character to demand it, you (supervising inspector) will, upon notifying the proper officer of the State board, be permitted to investigate the case, in connection with such person or persons as may be appointed to accompany you by the State board."

The proposition, which is almost a literal reproduction of a resolution approved April 19, 1881, by the Louisiana State board of health, is unhesitatingly accepted.

Proposition No. 2.—"That the State board will consent to a modification of the resolution lately adopted by it relative to investigation of cases so as to provide that, unless the report be ultimately unanimous, a majority or minority report shall be made to both boards, this being the course suggested by the National Board of Health."

With due respect for the suggestions of the National Board, the Louisiana State board still adheres to its opinion, embodied in the resolution already adopted by it, that there should be only one report sent to both the National and State boards, viz, the report of the majority of the investigating committee. By the resolution to which we refer, the State board has constituted that investigating committee in a manner calculated to give the greatest security to both boards and to the public at large as to the correctness of the decision at which they may arrive. One of them is to be selected by the National Board of Health, the other by the State board; in case of disagreement, these two are to select an umpire of their own choice, having all the necessary qualifications as to competency and character. A decision arrived at by a majority of a tribunal so composed presents all the guarantees in point of certainty and correctness which may expected in all human affairs, and we think that it would be improper and dangerous to impair the authority of such a decision by suffering a counter-report to influence the public mind, and create perhaps a general panic. All measures adopted by either board, based upon such a majority report, will be more favorably received by the community and will inspire general confidence; the enforcement of such measures will be rendered thereby easier, and will be more willingly submitted to. In most cases the boards would be without elements necessary to enable them to decide between two conflicting reports. By the adoption of one report the duties of both the National and State boards of health will be greatly facilitated; all hesitation or controversy will be avoided in time when delay may be fatal; measures of sanitation recommended will acquire greater weight and will be productive of more beneficial results. These are the reasons which induced our State board of health to adopt the one-report plan, and for the same reasons it feels compelled to refuse their assent to the second proposition.

Proposition No. 3.—"That in view of the great importance of securing the reports of the earliest cases of yellow fever, and the special stress laid upon this point in his (the supervising inspector's) instructions, which, either through ignorance or negligence of those upon whom the State board is forced to depend, might not otherwise be reported, the board (Louisiana State) be requested to approve of his (the supervising inspector's) issuing an appeal to our physicians, medical and sanitary organizations, &c., to furnish him with such information as they may have. He (the supervising inspector's) pledges himself, on condition of the approval, to report any information so secured as may be of value to the State board."

It seems to us that such an appeal on the part of the supervising inspector of the National Board is superfluous. Our rules and regulations make it compulsory on the part of every practitioner of medicine, surgeon, druggist, master of any water-craft, boarding or lodging house keeper, principals or masters of any boarding-school or seminary, &c., to report, within twenty-four hours after the same may come under their treatment, cognizance, or supervision, all cases of contagious, infectious, epidemological diseases, especially cholera, *yellow fever*, small-pox, diphtheria, trichiniasis, typhus or ship fever, or any of the grades of such diseases. The neglect to report all such cases renders the delinquent liable to a fine of twenty-five dollars for each and every offense, and in default of payment thereof to an imprisonment not to exceed thirty days. (See article 452 of an ordinance relating to contagious and infectious diseases, No. 4916, administration series.) It is the firm intention of this board strictly to enforce the law on this subject.

The persons upon whom the State board chiefly depend (and in its opinion justly rely) for early information are its experienced, competent, and sworn officers and the whole body of the licensed practioners of the city of New Orleans. The ignorance or negligence which seems to be apprehended by the National Board of Health does not very certainly refer to them. Outside of physicians the appeal sought for would have to be addressed to the very same parties upon whom the State board depends in a manner for information, and we do not see, if the danger of ignorance or negligence on their part exists in their relations with the State board, how the same danger will not exist in their relations with the National Board. With this remark we can see no objection towards granting to the supervising inspector the privilege of issuing his appeal, it being well understood that the information which may be given to him will not relieve the parties concerned from the duties imposed upon them of making their reports, as heretofore, to the Louisiana State board, the only authority constituted by law to receive their official communications.

The fourth proposition reads as follows: "In the case of yellow fever appearing in the city during the summer, it is the desire of the National Board to co-operate in every way with the local authorities of the city to restrict the spread of the disease and to stamp it out if possible, and to this end it will be prepared to pay for such services and materials as are necessary for this purpose. It will, therefore, become your duty (that of the supervising inspector), as its representative and chief executive agent in New Orleans, to decide what measures are necessary and proper for the purpose indicated, and to see that they are applied as promptly and energetically as possible."

In relation to this proposition we can but heartily approve and congratulate ourselves upon the so-expressed desire of the National Board to co-operate with us in all measures intended to stamp out yellow fever, if possible. We should have, however, desired that the benevolent efforts of the National Board should not have been limited to the contemplated emergency of an epidemic already existing, but should been extended to measures calculated to prevent its outbreak, thus applying the maxim so appropriately quoted by the honorable representative of the National Board, "In time of peace prepare for war."

We now come to the fifth and most important proposition or request made by the National Board to the State board of health, viz: "It is considered highly desirable by the National Board that infected ships should be, as far as possible, excluded from the Mississippi River, and the inspector will endeavor to secure the co-operation of the Louisiana board toward obtaining this result, by having said board pass an ordinance similar to the resolution passed by the sanitary council of the Mississippi Valley at its last meeting, to the effect that all vessels from ports in which yellow fever is prevailing, or from ports where contagious or infectious diseases are reported to exist, shall be inspected at Port Eads, and if any such be found to be infected, or to furnish reasonable ground for suspicion of infection, such vessel shall not be allowed to pass Eadsport northwise, except upon presentation of a certificate from the inspector of the National Board of Health at the Ship Island quarantine station, setting forth

that the vessel has been subjected to proper treatment and is not liable to convey contagion."

With all deference and respect for the National Board, and in spite of our most earnest desire to establish friendly relations and promote our cordial co-operation in order to accomplish our most cherished object, our ambition to protect our city and State, as well as the States of the Mississippi Valley, from the introduction of foreign pestilence, of yellow fever more particularly, we must acknowledge that this proposition is a cause of surprise and regret to us, for it is entirely inadmissible and impossible that we could for a moment consent to it.

Ship Island is a sand bank situated on the coast of the State of Mississippi, 100 miles from the mouth of the Mississippi River, entirely out of the course of any vessels coming to this port from any of the ports most likely to be infected, such as Rio Janeiro, Havana, and Vera Cruz. Admitting that Ship Island was the safest and the best equipped quarantine establishment in the world, that the said island presented all the sanitary advantages, with all imaginable facilities for loading and unloading vessels, for provisions, &c; admitting that it was surrounded by deep water, permitting ships of heavy draught to load at the piers or wharves of said establishment; admitting all this, and everybody knows that the actual facts are quite the reverse, we say that this State board of health has no power conferred upon it by any of the several acts of the legislature creating said board and establishing quarantine for the protection of the State of Louisiana to order vessels out of the waters of Louisiana to any foreign or domestic port, or to any quarantine station under the jurisdiction of the United States or any State of the Union. To assume such power would simply be an abuse of authority on the part of the State board, which would not be tolerated by our State authorities nor any foreign power. Admitting that we should have the power to prevent admission in the Mississippi River of a vessel of a friendly power, doing legitimate business with our port, we have no right to force her out of her way; to be submitted to a thousand vexatious annoyances and trouble; to oblige her to procure a certificate from the inspector of the National Board of Health at the Ship Island quarantine station.

The distance from Ship Island to the mouth of the Mississippi River is 100 miles; a sailing-ship during bad weather and unfavorable wind might be several days on the way.

Supposing that a vessel, after obtaining this certificate, which is to open to her the gates of the Mississippi River, should have cases of yellow fever, or other infectious diseases, to declare themselves on board of her on her way back from Ship Island station to Eadsport, an occurrence likely to take place under this latitude during the months of August and September, what then should be done with such a vessel? Should she be sent back a second time to the national station to undergo a second quarantine?

The proper place, the only one we recognize for vessels from foreign ports bound for New Orleans, to be stopped, inspected, and submitted to quarantine, established by the laws of the State of Louisiana, is our State Mississippi River quarantine station. It is admirably situated for that purpose, at a sufficient distance from our city to protect us from the neighborhood of infected ships, and yet near enough to procure provisions, supplies, acclimated laborers, physicians, nurses, &c., in case of necessity. It offers a safe and deep anchorage to immense fleets. This establishment has, under the administration of the present board of health, been put in thorough repair at a cost of nearly $7,000. It represents a value of $60,000, with large warehouses for storing cargoes; also, facilities for loading or unloading at the wharf. It has telegraph communications with all parts of the world. It is the best equipped and organized quarantine station outside of New York.

The rules and regulations governing our quarantine station are sufficiently strict to procure complete protection from foreign pestilence with as little detention and obstruction to commerce as possible.

Should we accept the proposition to inspect vessels at Eadsport and not allow them to pass northwise, except upon the presentation of a certificate of the inspector of the National Board of Health at Ship Island; in other words, should we force (if we had such power) the Ship Island quarantine upon foreign or domestic commerce, we should at once, to be consistent, abolish our State board with its well-equipped and costly quarantine establishments in the Mississippi River; we should at once abandon the power and authority conferred upon us by law; we should abandon the fulfillment of our sworn and sacred duties, that of protecting ourselves, the lives of our people, the interests of our commerce, not confiding to others, however great and powerful they may be, that sacred obligation.

Commerce once destroyed, as it would surely be by the enforcement of this strange and unnatural quarantine which is sought to be imposed upon us, we might as well abandon all our rights, powers, and duties, for Louisiana would no longer need any protection. It would be entirely ruined, and would soon disappear from the family of States. For all these reasons, and many others which we could add to these, we respectfully refuse to indorse the fifth and last proposition submitted to us by the supervising inspector of the National Board of Health.

In considering the above-mentioned proposition emanating from the National Board of Health, we have acted fairly, honestly, good intentionally, as we have done on all occasions in which points of dissension have arisen between the National Board of Health and the Louisiana State board. We consider it our duty, we deem it is due to both ourselves and our fellow-brothers of the National Board, to give fully and explicitly our honest opinions and convictions on subjects of such vital importance as those that relate to the public health.

We hereby reiterate our most earnest desire to extend our friendly relations with all sanitary organizations—with the National Board of Health more particularly. The object we are striving for is the same; public health is our aim and ambition. Each organization, in its own sphere of action, has its share of usefulness, and contributes to the public good. From the combined yet distinct efforts of all, beneficial results will certainly be accomplished. We of the Louisiana State board shall always be found ready to co-operate, to the utmost limit of our power to do so, in all measures having in view the interest and welfare of our common country.

Prior to the unanimous adoption of this report by the State board, Dr. Chaillé urged upon its attention the fact that the adoption of the Ship Island proposition could not possibly prove so disastrous that Louisiana "would be entirely ruined and would soon disappear from the family of States"; for in 1880 there had not been a single vessel, and in no one year had there ever been recorded more than six vessels which presented such evidence of infection that the National Board of Health would have required them to go to Ship Island. In proof that these were the views of the National Board of Health, a letter to the above effect from its president was read. None the less the vote taken on the report after this information was given was unanimous. This fact and the need for correcting various misapprehensions on the subject rendered necessary the following:

Reply to the above, read at the meeting of the Louisiana State board, held June 9, 1880.

To the Louisiana State Board of Health:

GENTLEMEN: In your report, adopted May 19, in reply to the five propositions of the National Board, submitted to you on May 13, you use the following encouraging language:

"We consider it our duty, we deem it is due both to ourselves and to our fellow-brothers of the National Board, to give fully and explicitly our honest opinions and convictions on subjects of such vital importance as those that relate to public health. We hereby reiterate our most earnest desire to extend our friendly relations with all sanitary organizations—with the National Board more particularly. The object we are striving for is the same; public health is our aim and ambition." "We of the Louisiana State board shall always be found ready to co-operate, to the utmost limit of our power to do so, in all measures having in view the interest and welfare of our common country."

The present representative at New Orleans of the National Board heartily reciprocates these sentiments, which encourage him to believe that you will patiently listen to some "honest opinions and convictions" opposed to your own, and that you are as anxious as he is to rid every question between you and the National Board of all misapprehensions and false issues.

On one subject, which may be termed the Eadsport and Ship Island quarantine question, it is respectfully but firmly believed that your report gives proof of serious misapprehensions respecting the position of the National Board on this question. Inasmuch as this same position has been taken by the sanitary council of the Mississippi Valley, and also by the Auxiliary Sanitary Association and the Medical and Surgical Association of New Orleans, it is not likely that discussion will cease until all misapprehensions have been removed, and some general conclusion has been reached on the true issue. As to what I may say on this subject, I beg leave to remind you that, although I represent in this city, for the summer only, the National Board, I still remain one of your constituents; that, as a citizen of New Orleans, my love for it, my home reputation, and my money interests all located here, greatly exceed any temptations which the National Board could possibly present me; and, therefore, that my convictions are not those of a salaried partisan, but of a fellow-citizen who has the permanent welfare of New Orleans nearest his heart, and who cannot be in any way so greatly benefited as by promoting its prosperity.

You have refused the request of the National Board—that you would co-operate with it in not permitting vessels "infected or furnishing reasonable grounds for suspicion of infection" to pass Eadsport without evidence that they had been thoroughly disinfected at the Ship Island quarantine station, for the following reasons, as expressed in your report or in the discussion which followed: Because it would be illegal to grant this request; because vessels would forfeit their insurance policies; because the commerce of New Orleans would be so destroyed that even Louisiana would be ruined; and because the Ship Island quarantine could not furnish protection as efficient as is given by your own Mississippi River quarantine station. These four reasons for your refusal will now be considered.

1.—THE ILLEGALITY.

On April 12, 1880, you referred this question to the Hon. J. C. Egan, attorney-general, who on April 22 thus replied: "I consider that, for

the purpose of quarantine, it would be in the power of your board to order ships coming to this port back to Ship Island as a condition to their entry, if, in your opinion, such a measure would tend to the better security of the State from infectious diseases." In addition to this official opinion I have consulted three of the most distinguished legal firms in this city, and all of them agree, even a member of one of these firms who doubts the expediency of such action, that your board has the power in question. The Hon. T. J. Semmes expressed his opinion in these words: "The State board of health has the power to exclude vessels from entering the Mississippi River, and as a necessary consequence can prescribe the terms of admission." My confidence in these opinions is so firm that nothing, unless a contrary decision by our highest courts, is likely to shake it.

The attorney-general adds to his conclusion the opinion that you ought not, without the personal service of your own agents, to regard the certificate of the chief medical officer at Ship Island as "conclusively satisfactory." No one has called in question your power and right, on making the requested concession, to impose such conditions as may be proper. The National Board would cheerfully consent to your posting one of your own inspectors at Ship-Island itself, as well as at Eadsport, who, with your officers at the Mississippi River quarantine, could certainly furnish such additional evidence as would be "conclusively satisfactory" to you.

Finally, on this question of legality, it is worthy of your attention that local boards in adjacent States have not been embarrassed by it. By some of these boards infected vessels have been prohibited, until after their thorough disinfection at Ship Island, from entering their ports; by this measure, the only practical one, these boards have enforced the advice of the National Board, which has never attempted itself to exercise any forcible compulsion, either on local boards or on infected vessels.

2.—FORFEITURE OF INSURANCE.

The same legal firms were consulted on this question, and the reply was unanimous that vessels refused admission by you to the Mississippi River and advised to proceed to the quarantine at Ship Island would not by their compliance forfeit their policies. My attention was called to the highest authorities on the law of marine insurance, to Parsons, Phillips, Arnould, and Kent, all of whom substantially agree that a policy is not forfeited unless the vessel deviates without adequate cause from its prescribed route; that "no act done under compulsion can be regarded as a deviation;" that the orders of officers of a State are compulsory; and that compulsion, even if illegal, protects the policy from forfeiture.

Four of the most noted presidents of our most respectable insurance companies were also consulted, and these likewise united in the opinion that vessels would not forfeit their nisurance policies. They added that, should your board take the action required by the National Board, the underwriters in this city could take instant action to quiet every question; and that the same action could be taken, with brief delay, by underwriters in other ports whether domestic or foreign.

This evidence has satisfied me that vessels, if required by you, whether indirectly or directly, to proceed from Eadsport to Ship Island for quarantine purposes, would not forfeit their insurance policies; and that if there were any such danger, the remedy would be promptly and easily found.

3.—DESTRUCTION OF THE COMMERCE OF NEW ORLEANS.

You are not requested to prohibit the passage above Eadsport of any vessels whatever, except only those "infected or furnishing reasonable grounds for suspicion of infection." The amount of injury to commerce will depend on the proportion which the number of such vessels bear to the total number of vessels entering the Mississippi River. It is believed that the number of the latter has varied during the past ten years from about 800 to 1,300 annually. To estimate the number of the former I have examined the evidence for the past ten years in the annual reports of your board, and have found that these contain nothing whatever to indicate that there has ever arrived in any one year more than six vessels, either infected or which would have been under any interpretation suggested by the National Board reasonably suspected of infection. Your report for 1880 is the most satisfactory one on this subject yet published, and is for an unusually prosperous year. Out of 1,271 vessels entering the Mississippi River you did not deem it a wise precaution to detain more than the exceptionally large number of 151, and of these there was not one which was either infected or reasonably suspected of infection. Only one vessel out of the total 1,271—the bark Excelsior—ever gave any evidence either of infection or of reasonable suspicion of infection; and your own report also shows that there was no evidence of this at Eadsport, nor until this vessel reached New Orleans. Now, it is respectfully submitted that the detour of not exceeding six vessels annually from Eadsport to Ship Island and back could not prove by any means disastrous to the commerce of New Orleans.

It may well be urged that the phrase "reasonable grounds for suspicion of infection" is a very elastic one and liable to great abuse. But no one has disputed your power to fix precise limits to the signification of this phrase, and to assign to duty at Eadsport your own inspector, together with an inspector of the National Board, with orders to enforce no interpretation except your own of this phrase. It has never been denied that you alone have all the power in this matter, and therefore can dictate your own conditions. An inspector of the National Board at Eadsport could not, under present laws and regulations, exercise any more power there than its inspectors now at New Orleans and at the Mississippi River quarantine station exercise at these places, unless you saw fit to delegate to him some part of your own power. Surely it would be easy to check, when and how you pleased, the least tendency to injure the commerce of this city, whether this tendency was or was not justified by wise precautions for the public health.

These facts satisfy me that the injury to our commerce would prove insignificant in comparison with popular misapprehension on the subject, and slight in comparison with the good it is believed would ensue.

4.—SHIP ISLAND QUARANTINE NO ADDITIONAL PROTECTION.

The National Board long since declared that it had no desire to "abolish the State board," nor to usurp "the power and authority conferred upon it by law," nor cause you "to abandon the fulfillment of your sworn and sacred duties," nor to impair the resources of your board. On the contrary, the National Board would rejoice to see your power and resources increased; for, disregarding less selfish considerations, is it not evident that, since it is a paramount duty of the National Board to aid and co-operate with local boards, the greater the influence of these, the greater must be its own?

The National Board has requested you to co-operate with it in providing New Orleans with what, it is believed, would prove an additional protection to the public health, and urges this for the sake, not only of this city, but also of many adjacent communities who firmly believe themselves in constant danger whenever New Orleans becomes infected. Would the Ship Island quarantine, as a station of refuge for infected vessels, furnish any additional protection? Stripping the disagreement between the two boards of all misapprehensions and false issues, this, in my opinion, is the sole question for consideration.

On May 8 I inspected your Mississippi River quarantine station, and testify, with pleasure, that I found it better than I had expected, and that I detected nothing to indicate that the officers in charge were not discharging their duty to the best of their ability, and as efficiently as the circumstances and the means at their disposal permitted. But I think that our future protection demands that these circumstances and means should be fully appreciated, for thus only can our legislature be induced to give you the liberal aid required, and thus only can we secure from others needed sympathy and aid.

You report that Louisiana has on the Mississippi River "the best equipped and organized quarantine station outside of New York." As I have not inspected all of the others I cannot add my testimony to yours, but I do know that no place in the United States has proved itself as liable to yellow fever as has New Orleans, and, therefore, that our quarantines should be second to none in efficiency. Dispensing with minor criticisms, I found two very great defects at the chief one of our three quarantine stations.

First. If there be any police force it is inadequate to prevent communication between the quarantine grounds and the neighborhood; it is inadequate to prevent the passengers and crews of infected vessels from communicating with uninfected vessels and with the residents below, above, and over the river opposite to the station; it is inadequate to prevent such passengers and crews from occasionally avoiding at Eadsport or elsewhere your quarantine and in reaching this city by towboats or otherwise; and it is inadequate for the protection of Eadsport itself, as testified by Capt. James B. Eads in his letter published this day in the Democrat. Unless more amply provided with funds I do not believe it in your power to remedy this defect.

Second. Sanitation demands the thorough cleansing of an infected vessel, and this necessitates the discharge of its cargo, while commerce demands that these things shall be done promptly and economically, and these demands require an abundant supply of cheap labor. When inspecting the Mississippi River quarantine station I found one vessel paying $6 a day to every laborer, and the number secured by importation from New Orleans was inadequate, even at this price, to insure the thorough and prompt unloading, cleansing, and reloading requisite for the conjoint interests of sanitation and commerce. This grave defect is also out of your power to rectify. Nevertheless, however powerless you may be respecting the two defects cited, sanitarians and merchants, or both, will remain dissatisfied until some remedy for them is found.

The first defect is so inseparable from quarantine stations on the mainland that sanitarians unite in demanding their location on islands. Besides this inestimable advantage, I have been assured that an ample supply of laborers can be obtained at Ship Island for $35 a month. Further, I have much more confidence in the ability and will of the United States to make its station at this island as perfect as is practicable than I have in your gaining either from the legislature of this impoverished State or from the council of this impoverished city the aid necessary to perfect our three quarantine stations—an end which must be accomplished, unless we are to continue tampering with half-way measures. Appreciating fully our

great misfortune that Louisiana has no island for a quarantine station at the mouth of our river, and that Ship Island is so distant therefrom, and conceding that the three reasons now given in favor of this station may not be considered conclusively satisfactory, I will advance an additional reason, which, combined with the others, has sufficed to convince me that good policy dictates concession to the request of the National Board. The health authorities of the adjacent States of the Mississippi Valley demand this concession as necessary to their protection, and declare that, if their demand is not heeded, they will be forced to interrupt our commerce with them on the least suspicion of danger. Yellow fever is a public enemy, and our neighbors have as much right to a voice in its exclusion from the Mississippi River as upon the exclusion therefrom of any other public enemy. Louisiana has not hesitated, when to its advantage, to vociferate that the Mississippi River is a national highway, and that all the States should contribute to its jetties and levees; now, when other States demand what they think essential for the protection of their public health, shall Louisiana inconsistently reply that the mouth of this national highway is exclusively under its control, and shall be managed regardless of their wishes?

5.—GENERAL CONSIDERATIONS.

Several additional considerations deserve attention. Should our hope of greatly increased prosperity be fulfilled, then it is certain that our unacclimated population will increase, and thereby our danger of infection and our need for additional protection. Further, our traveling facilities will also be notably increased; with this the danger of infecting our neighbors, and with this their demands for better protection. These anticipated conditions will, it is to be hoped, continue to strengthen the pressure both within and without this city to keep itself clean and uninfected, and to adopt every reasonable precaution to attain these ends. Hence, it is idle to expect the present issue will die out, and if it be not met fairly and generously, then, when disaster overtakes us, as it may in spite of all efforts and concessions, New Orleans will find itself a helpless victim to the indignant distrust and hostile action of its neighbors. In this matter the National Board represents not only a large number of your fellow-citizens, and, in my belief, the health authorities of adjacent States, but also the same generous country which overwhelmed this city in 1878 with millions of dollars of bounty. Is it fitting to refuse a concession urged by such applicants, and to attribute to a mean spirit of commercial jealousy their anxiety to shield timid communities, which are not hardened by habit to our dreadful scourge, nor protected as we, in large numbers, are by acclimation? They ask no more than an apparent sacrifice of an insignificant fraction of our foreign tropical trade in lieu of what they deem better security both for them and for us, and in lieu of annual jeopardy to our inestimably more valuable interstate commerce. For my part, I advocate proving to our neighbors that we love them as ourselves, and I therefore would concede to them a voice, though opposed to our own, in controlling the importation of yellow fever into the mouth of our great national highway.

Your concession would result, I am confident, in diminishing our risks of infection, and, thereby, would tend to promote our growing grain trade, our European imports, our home manufactures, and our languishing summer business. Your concession would certainly accomplish the very desirable end of giving notice—as, apart from the consideration of an inspector at Eadsport, should, I think, be given by you—to all owners, agents, and captains that vessels certainly infected shall no longer be permitted even to enter our river, but must, when destined for the Mississippi, proceed directly to the refuge for such vessels at Ship Island. By such measure you would teach them a much-needed lesson, namely, to enforce that better sanitary construction and regulation of their vessels which has enabled some steamship lines to ply between Havana and New York for a decenniad without having had a single case of yellow fever on board. This good result alone weighs heavily in the balance against the slight temporary injury to our commerce, and would, by permanent advantages, ultimately more than compensate this commerce.

Further still, your concession would give you greater influence in eventually promoting measures most desirable for our commerce; such, for instance, as gaining the aid of the United States in establishing quarantine stations perfectly satisfactory both to adjacent States and to Louisiana; and such as the stationing of sanitary officers both at Rio and Vera Cruz, whereby our intercourse with these ports would be rendered much safer, and the interests of our coffee and other trades would be greatly promoted.

In conclusion, gentlemen, it is my conviction that this question merits your further consideration, your personal inspection of the Ship Island quarantine station, and of all the subjects pertaining thereto, and that you would give great satisfaction to many of your fellow-citizens, within and without this State, should you consent to reconsider your refusal, based on what, I have now stated my reasons for believing, were misapprehensions of the position on this subject of the National Board.

Very respectfully, yours,

STANFORD E. CHAILLÉ,
Supervising Inspector National Board of Health.

On June 16 Mr. I. N. Marks, the president of an insurance company and a member of the State board, read before it the following communication in support of the position taken on the subject by the board:

My position on the insurance question, as connected with the Ship Island quarantine, has not been properly stated.

I do not claim that if compulsion or force was used by the National or State authority in sending a vessel from the mouth of the river to Ship Island that such deviation in the voyage would vitiate the insurance on vessels and cargo if an accident occurred during the deviation.

I lay down the following propositions:

1. That neither the National or State board of health has the legal right to compel an infected vessel or one having the suspicion of infection, destined to the port of New Orleans, to deviate from her direct voyage and proceed to Ship Island or any other point outside of the territory of Louisiana.

2. That such legal power not being vested in the State board of health of Louisiana, that the captain of a ship, taking it from the mouth of the river to Ship Island on the *simple order* of an officer of the board of health, would be (on his part) performing a *voluntary* act.

3. That apart from the illegality of any such order, the necessity for a compliance with it or for its execution does not exist.

4. That the State of Louisiana has (under its laws) provided a well-ordered, thoroughly-equipped, and efficient quarantine station to which all vessels from infected ports must go for detention, inspection, fumigation, and disinfection.

5. That, the foregoing being admitted, it would be unwise and unnecessary to attempt to illegally force a vessel to proceed to a place unfit, from its geographical position, its proximity to the thickly-inhabited coast of Mississippi, its constant intercourse with the inhabitants of said coast, its want of a safe anchorage for vessels, its constant exposure to storms, for quarantine purposes.

6. That if the captain of a vessel, in the absence of physical force, and in the face of the want of a necessity for the act, takes his ship from Eadsport to Ship Island, in the eyes of the law he voluntarily deviates from his voyage, and vitiates the insurance on vessel and cargo.

7. That if the State board of health possessed the physical power (and it does not) to forcibly take a vessel to Ship Island, and an accident happened to said vessel, and the insurance company paid the loss, the said company could, in my opinion, recover from the board of health the amount involved, on the just ground that the loss had been occasioned by an illegal act on the part of said board.

The foregoing propositions I distinctly lay down and maintain.

The writer in the Democrat, whose communication I have read, makes certain extracts from Philips and Parsons on Marine Law, giving only such portions of such sections quoted as suits his purpose, suppressing or withholding the more important (in this case) conclusions. He quotes as follows:

Philips says: "The doctrine of deviation has reference to voluntary acts or to neglect, and not to unavoidable interruption of the voyage." Vol.—, sec. 984, page 565.

Philips does not terminate his section as above, for at the word voyage he uses a semicolon, and not a period, as S. quotes it, and then goes on to explain his opinion by adding: "Such as, the vessel being driven from the course in a storm, or being taken possession of by a mutinous crew. But in case of a master of a vessel going out of harbor, by order of the captain of a frigate lying near, to examine a strange sail, Lord Ellenborough ruled it to be a deviation, remarking that if he had gone by compulsion, and under threat or just fear of violence, it would not have been so."

Philips again says, sec. 983, page 556, vol. 1: "It is not necessary to a deviation or change of risk, whereby the underwriters are discharged, that the degree or period of the risk should be thereby increased. The assured has no right to substitute a different risk."

S. quotes from Parsons as follows: Parsons says, "Deviation applies only to a voluntary act. The definition shows that any change which can be justified or shown to proceed from a just cause is not deviation." Vol. 2, sec. 5, page 28.

Parsons continues: "And of course no act done under compulsion can be regarded as a deviation. The change of risk, to operate as a deviation, must not be only voluntary but unnecessary; or rather, if it be necessary, it must be considered as compelled rather than as voluntary."

From the foregoing it seems perfectly clear that the attitude of this board upon this question is correct, legal, and rational.

Second proposition in reference to the Eadsport and Ship Island quarantine question.

NATIONAL BOARD OF HEALTH,
New Orleans, La., June 16, 1881.

Prof. JOS. JONES, M. D.,
President Louisiana State Board of Health:

DEAR SIR: In the event that your board declines to reconsider its refusal (May 19) of the application (May 13) of the National Board

for permission to station at Eadsport an inspector, with power to prohibit infected vessels from entering the Mississippi River until after their thorough disinfection at the refuge station at Ship Island for such vessels, it is respectfully urged that your board consider the expediency of adopting such measures as would tend to cause infected vessels bound for the Mississippi to proceed *directly to the Ship Island quarantine station* for thorough disinfection prior to attempting to enter the mouth of said river. This result might be accomplished by the adoption of a regulation prohibiting vessels which have any cases of yellow fever on board, or which have had any such cases while either at the port of departure or *en route* from passing into the Mississippi until such vessels, very few in number, have been thoroughly disinfected at Ship Island.

The public advertisement of such a regulation, together with the notification thereof of pilots and of consuls, would promptly diminish to the utmost the inconvenience to commerce, and it is believed that ample power to execute such a regulation will be found in section 1 of the act of Congrees "to prevent the introduction of contagious and infectious diseases into the United States," approved June 2, 1879.

Such a regulation would cause three good results: It would induce those who control vessels bound to this port to adopt better sanitary measures for protecting their vessels from becoming infected; it would furnish additional protection to this city; and it would very surely give an additional feeling of security and great satisfaction to all communities in close commercial intercourse with New Orleans.

Very respectfully, yours,

STANFORD E. CHAILLÉ,
Supervising Inspector.

OFFICE BOARD OF HEALTH, STATE OF LOUISIANA,
New Orleans, June 23, 1881,

Dr. S. E. CHAILLÉ,
Supervising Inspector National Board of Health:

DEAR SIR: I am instructed by the president of the board to acknowledge receipt of your two communications of recent dates; one relative to a steam-launch for the use of Dr. Patton at the Mississippi quarantine station, the other relative to sending infected vessels to the Ship Island quarantine. The communications were read by the president to the board, but no action was taken thereon, the president being simply requested to acknowledge the receipt of the same.

Respectfully, your obedient servant,

[L. S.] S. S. HERRICK, M. D., *Secretary.*

The above was the only reply ever received to the preceding and following letter, except that Dr. Jones stated verbally that he doubted the board's power to appoint a sanitary policeman on the United States steam-launch, and that he did not admit that there was any improper communication rendering it necessary.

NATIONAL BOARD OF HEALTH,
New Orleans, La., June 10, 1881.

Dr. JOS. JONES,
President Louisiana State Board of Health:

DEAR SIR: In case I should apply to the National Board of Health for permission to send its steam-launch to Mississippi River quarantine for the use of our officers there, would you agree to place on it a sanitary policeman, with authority to use said launch for, among other purposes, preventing improper communication with said quarantine station and with New Orleans?

I believe that, with this understanding, the permission might be given me.

Yours, very truly,

S. E. CHAILLÉ,
Supervising Inspector.

APPENDIX 6.

New Orleans, May 24, 1881.
OFFICE OF THE SUPERVISING INSPECTOR OF THE
NATIONAL BOARD OF HEALTH,

DEAR SIR: It has been made my primary duty, as "the representative and chief executive agent" in this city of the National Board of Health, to obtain the earliest possible information of the existence of yellow fever in New Orleans or its vicinity." To fulfill this duty, I am instructed, among other measures, *to endeavor to secure* from the "physicians of New Orleans and the river parishes below New Orleans," and from the "sanitary and medical organizations of the city," prompt information "as to the presence of cases of yellow fever, or of doubtful or suspicious cases of this disease."

There are three considerations which deserve your attention when determining the question whether you will contribute this information. First, the health authorities of neighboring States insist that prompt notification of the whole truth respecting the appearance of yellow fever in New Orleans is indispensable for their own protection, and warn us that any failure to furnish this information will force them so to act that far greater detriment would thereby result to this city than from reports of all the facts. Second, all must concede that, if the spread of yellow fever can be prevented, sanitary measures should be speedily applied to the very earliest cases, whether real or reasonably suspected. Third, the laws of Lousiana, as well as the regulations (authorized by the laws of the United States) of the National Board of Health, inferentially declare that yellow fever is a portable disease, inasmuch as they provide means to prevent its importation and its spread, and the ordinances of the city of New Orleans enforce the same view by enjoining the prompt report of all cases of this disease to the State board of health; hence, all law-abiding physicians and citizens are bound to facilitate the application of these measures, even though they, in some instances, may be convinced that our laws are founded in error, and that no available measures can be or will be applied to prevent the importation and spread of yellow fever.

These facts justify this application to you for the aid indicated, and while you are under no legal obligation to give this aid to a sanitary officer of the National Board of Health, it is none the less believed that your compliance would not only promote the public welfare and the interests of science, but would also relieve you, in respect to the public health, from a very grave responsibility officially imposed on others.

Where the objection of the patient or of his attending physician would make my inspection of the former, in company with the latter unadvisable, the attending physician is earnestly requested to keep and promptly to report a careful record of the history of every case which he knows or fears to be yellow fever; and the same course is deemed very desirable respecting all cases of hæmorrhagic malarial fever, or other fevers which simulate yellow fever. Any summons for or report to me should be sent to my office, in the third story of the University building, at the corner of Common and Baronne streets, or to my residence, No. 24 South Rampart street, between Common and Canal streets, and any necessary expense incurred therefor will be refunded. If there should be satisfactory cause to request it, Dr S. M. Bemiss, resident member of the National Board, would, no doubt, consent to serve as my substitute in examining any cases or supposed cases of yellow fever.

In order that you may better understand the character and purpose of the aid requested, a printed copy of my official instructions is enclosed, to which, and especially to Appendix D, your attention is solicited.

Since it is most important that I should know what are to be the sources of information upon which I can rely, you are earnestly requested to reply to this communication, furnishing your full address (and, if in the country, the location of your practice), and stating whether you will be good enough to give the aid solicited.

Very respectfully, yours.

STANFORD E. CHAILLÉ, M. D.,
Supervising Inspector of the National Board of Health,
P. O. Box 1689, *New Orleans, La.*

Extract from a letter of the former health officer at Port Eads to Dr. Chaillé.

"I wish to call your attention to matters pertinent to your circular. Quarantine is established in this State forty miles above Port Eads. Vessels from all parts of the world come to an anchor at this place and stay during their pleasure, many of them from infected ports. Often the captains, and sometimes their wives and children, come ashore and go to New Orleans, either on the mail-boat, tow-boats, or steamers. There is always more or less communication between the vessel and shore, persons go aboard, and there is no restriction upon intercourse.

"The custom officers and crew are not acclimated; they come and go with perfect freedom, and the custom-house is in the midst of the settlement."

Here follows a statement of a supposed case of infection by yellow fever on a vessel in 1878, and the exposure of Eadsport in the same year to small-pox infection.

"My object in writing the above is to impress upon you the importance of having some one here to represent the National Board of Health, or the State board, or both, with authority to board all vessels, especially those from infected places, and to prevent their remaining here. It seems to me that this place is liable to start an epidemic at any time, and if there is any virtue in quarantine restrictions here is the place to commence work. Your representative here should have a boat and boatman, and should go to each vessel. I assure you this is a very important matter, and in my humble opinion your quarantine regulations are very defective without this place being guarded against."

J. H. STOCKLEY,
Former Health Officer to Jetty Company,
Port Eads, La., May 30, 1881.

EVIDENCE OF DR. RYAN.

Report of the proceedings of the Louisiana State board of health on July 28, from the Daily Picayune of July 29, 1881.

"A communication was read from Dr. Ryan, quarantine physician at Port Eads, stating that the telegraphic operator there boarded every vessel which arrived, and that the officers and employés of the custom-house, after boarding vessels from infected ports, occasionally arrived in New Orleans some days before the vessel. Dr. Jones stated that the operator had no authority whatever from the board to board vessels, and that the collector of the port would be notified of the charge made against the officers and employés of the custom-house at Port Eads."

On July 28 the State board "*Resolved*, That a committee of three be appointed by the president to investigate the discretionary powers of the quarantine physician in regard to allowing acclimated persons to come up to the city from vessels from infected or suspected ports, and to draft recommendations for his guidance in such cases that come under section 3 of the act of March, 1855."

On August 11 the report of the committee was adopted, and was as follows:

"Your committee, after a careful consideration of the whole subject, beg leave to report that, whilst they do not believe that Dr. J. F Finney, resident physician at the Mississippi River quarantine station, has abused the power conferred on him by the act of 1855 relative to acclimated persons, still we consider the fact of allowing acclimated persons to hold communication with or to come from ships detained at the quarantine station to be of such grave importance to the public health of this city that the matter is one that ought to be under the immediate direction of this board: Therefore, be it—

"*Resolved*, That Dr. J. F. Finney, resident physician at the Mississippi River quarantine station, be instructed not to permit any person, acclimated or unacclimated, to leave any ship, for any purpose whatever, detained at the Mississippi River quarantine station, without a recommendation from Dr. Joseph Jones, president of the State board of health."

On August 18 a member of the State board reported to it, in reference to the Rigolets quarantine station: "Inspection is the gist of the whole matter, and this should be conducted very differently from the manner set forth in the sworn testimony before the board."

APPENDIX 7.

Charges against Quarantine Inspector Patton.

At the meeting of the Louisiana State board of health, September 15, 1881, Dr. Jones said he had been requested to read the following letter:

QUARANTINE STATION, MISSISSIPPI RIVER, LA.,
September 12, 1881.

Dr. STANFORD E. CHAILLÉ,
Supervising Inspector National Board of Health:

DEAR SIR: I have hereby to acknowledge the receipt of your letter enclosing extracts from New Orleans papers, in which my name occurs in a complaint made by Captain Calloway, of the British steamship Historian, to the State board of health as to the treatment of his vessel at this station and the conduct of the quarantine officers. As to his charge that I am in the habit of visiting the Buras settlement, I have to state that I have occasion to do so at least three or four times every week, as there is no post-office nearer.

I have had no "guests" in the sense implied by Captain Calloway. Early during my stay here my wife was with me for several weeks, and since her departure two other members of my immediate family, my wife's young sisters, have been keeping house for me. They are here with the consent of Dr. Finney; they have nothing to do with quarantined vessels, and, as in addition, they are acclimated, I can see no possible objection to their presence. I make this explanation to you, though in general I would not feel called upon to explain matters affecting solely my private domestic arrangements. As regards the charge that I telegraphed that a suspicious case of fever had occurred on the steamship Historian, you know yourself that this is utterly false, and you have my authority for so denouncing it through the press if you so prefer.

In conclusion, I beg to remain yours, very respecfully,
G. FARRAR PATTON, M. D., *Inspector.*

NATIONAL BOARD OF HEALTH,
New Orleans, September 14, 1881.

Prof. JOSEPH JONES, M. D.,
President Louisiana State Board of Health:

DEAR SIR: In justice to Dr. Patton, inspector National Board of Health, I would be obliged if you would have read at the next meeting of your board his enclosed communication [as above] in reply to the charges publicly made against him by Captain Calloway at the session of your board on September 8.

Respecting the charge that Inspector Patton reported a suspicious case of fever on Captain Calloway's vessel, I confirm Dr. Patton's denial of said charge as false.

As to the charges that he improperly visits the Buras settlement, and entertains "guests" at the quarantine station, I would be obliged if your board would indicate whether Inspector Patton has in any wise violated, in view of his statement of the facts, any laws of this State, or any of the rules and regulations of the Louisiana State board of health, which laws and regulations it is the imperative duty of all inspectors of the National Board of Health to comply with.

Yours, very respectfully,
STANFORD E. CHAILLÉ,
Supervising Inspector National Board of Health.

[Neither of the two communications immediately following were forwarded to nor received by the supervising inspector until October 3.—S. E. C.]

Extract from the minutes of the board of health State of Louisiana at its meeting of September 15, 1881.

A communication from Dr. Chaillé, supervising inspector of the National Board of Health, was read, accompanied by a copy of one from Dr. Patton, inspector of the National Board at the Mississippi quarantine. Dr. Patton asserted that his alleged guests at the station are members of his family, residing there by permission of the resident physician, and fully acclimated. He has to visit Buras two or three times a week, as it is the nearest post-office.

The president held that Dr. Patton had violated the law.

The board was censured last year on account of communication between the station and Buras.

The president stated that, after the charges of Captain Calloway, of steamship Historian, had been made before the board, he had called upon the governor, his excellency Louis A. Wiltz, and inquired whether any permission had been granted to the supervising inspector of the National Board of Health stationed in New Orleans, or the inspector of the National Board of Health stationed at the Mississippi quarantine, to introduce any parties either as guests or as the crew of a steam-launch upon and within the grounds of the Mississippi quarantine station. The governor stated that he had not granted such permission. After obtaining this information, he had addressed a letter to Dr. Finney, quarantine physician Mississippi station, making inquiry into the questions involved; up to the present date no reply has been received from Dr. Finney; but, when received, it will be laid before the board at the regular meeting.

In reply to an inquiry addressed by Dr. Jamison, whether the inspector of the National Board of Health had violated the laws of the State, the president said that by sec. 6 of "An act to establish quarantine for the protection of the State," approved March, 1855; sec. 1 of "An act supplementary to an act," approved March 18, 1858, and sec. 6 of "An act to establish quarantine for the protection of the State, to create a board of health, and to define its powers and duties," approved March 16, 1870, and sec. 7 of "Act 80, to reorganize and render more efficient the board of health of the State of Louisiana," approved April 20, 1877, the board of health was placed absolutely and unconditionally by the general assembly of the State of Louisiana in charge of the Mississippi quarantine station, and of all others within the limits of the State; and no one, whether an inspector or supervising inspector or member of the National Board of Health, had the right to introduce people under any pretext whatever within the quarantine stations of the State without the permit of the board of health, and in accordance with the rules and regulations of the board of health governing quarantine stations. (See codified acts of legislature and rules and regulations of board of health, pp. 51 and 52.)

Dr. Formento and Mr. Brewster found no violation of law on the part of Dr. Patton.

Dr. Jamison thought Dr. Patton's sense of propriety ought to guide him there.

Mr. Booth introduced a resolution on the subject, which was rejected by the following vote:

Ayes—Jamison, Marks, Booth.

Noes—Formento, Bean, Hernandez, Lanaux, Brewster.

A true copy.
S. S. HERRICK,
Secretary Board of Health.

OFFICE BOARD OF HEALTH, STATE OF LOUISIANA,
New Orleans, September 6, 1881.

Dr. JAMES F. FINNEY,
Resident Physician Mississippi Quarantine Station:

DEAR SIR: The board of health of the State of Louisiana has received information to the effect that G. F. Patton, M. D., inspector of the National Board of Health, has entertained, and is now entertaining, upon and within the limits of the quarantine grounds of the State of Louisiana, one or more individuals, and also that the said

inspector of the National Board of Health keeps a steam-launch, with one or more men, at the Mississippi quarantine station, and that in company with his guests, and with the crew of his steam-launch, holds communication with the inhabitants of the opposite bank of the Mississippi River, in the village known as the Buras settlement.

As Dr. G. F. Patton, inspector of the National Board of Health, was upon the request of the executive committee of the National Board of Health permitted by the governor of Louisiana to reside at the quarantine station for the purpose of furnishing, under certain definite conditions, information as to the absence of yellow fever, and the sanitary condition of the shipping, the president of the board of health of the State of Louisiana visited his excellency Governor Louis A. Wiltz, and inquired whether permission had been granted to the inspector of the National Board of Health to entertain guests at the Mississippi quarantine station.

His excellency Governor Louis A. Wiltz stated that he had granted no such privilege to the inspector of the National Board of Health, and that he had been permitted to reside at the Mississippi quarantine station in accordance with the proposition enunciated in the communication of Prof. J. L. Cabell, M. D., president of the National Board of Health, addressed to the president of the State board of health, on the 19th of February, 1881.

His excellency Governor Louis A. Wiltz regards the inspector of the National Board of Health, residing by his permission at the Mississippi quarantine station, as subject to the quarantine laws of the State of Louisiana as embodied in the organic acts of the legislature, and he holds that his permission granted to the National Board of Health may at any time be revoked.

Your attention as resident physician of the Mississippi quarantine station is directed to the following proposition contained in the letter of Prof. J. L. Cabell, M. D., president of the National Board of Health, of February 19, 1881.

* * * * * *

"1st. That an inspector of the National Board of Health be stationed at the Mississippi quarantine for the purpose of observation and inquiry, who shall have the privilege of inspecting, in company with the quarantine officer, all vessels arriving at the station, and who, in the event of the difference of opinion between himself and the quarantine officer as to the actual sanitary condition of such vessels and as to the treatment which they require, shall send to the president of the State board a copy of the report made to the National Board."

No other terms have been considered either by his excellency the governor, or by the board of health of the State of Louisiana, with reference to the presence of an agent of the National Board of Health at the Mississippi quarantine station, than those just quoted as enunciated by the Executive Committee of the National Board of Health through its president.

The resident physician of the Mississippi quarantine station will therefore, in view of the preceding facts and statement, furnish the board of health of the State of Louisiana specific replies to the following questions:

1. Has the inspector of the National Board of Health, stationed at the Mississippi quarantine station in accordance with the permission of Governor Wiltz, conducted himself in accordance with the terms laid down in the propositions of the National Board of Health just quoted? If he has not, give full particulars.

2. Has the inspector of the National Board of Health introduced any guests or employés within or upon the quarantine grounds of the State of Louisiana at the Mississippi quarantine station; if so, by whose permission have said individuals been introduced within the boundaries of the quarantine as established by the laws of Louisiana?

3. Has the inspector of the National Board of Health violated the laws of Louisiana by holding communications with vessels from infected ports and with the inhabitants of the opposite bank of the Mississippi River?

4. Has the inspector of the National Board of Health had yellow fever?

5. Have the individuals alluded to as his guests and employés ever had yellow fever?

The resident physician at the Mississippi quarantine station is respectfully urged to forward his replies to the above inquiries at the earliest practicable moment.

Respectfully,

JOSEPH JONES, M. D.,
President Board of Health State of Louisiana.

[The following letter was published September 30, as a part of the proceedings of the Louisiana State board on September 29.]

MISSISSIPPI QUARANTINE STATION,
September 13, 1881.

JOSEPH JONES, M. D.,
President Board of Health State of Louisiana:

DEAR SIR: Your communication of the 6th instant has been received and in answer to the questions therein contained I respectfully make answer as follows:

1. In reference to the inspector of the National Board of Health at this station conducting himself in accordance with the terms of the proposition of the National Board of Health to the State board, he certainly has not, and in more instances and ways than one. In the first place he has exceeded the bounds of his duty and the (superficial) object of his appointment in his letter to the representative of the National Board at New Orleans, containing comments on the expense to vessels from Rio de Janeiro in undergoing quarantine at this station, and suggesting as a remedy that all vessels from Rio be advised through the United States consul at that port not to trade with New Orleans from May to November of each year. In this same letter no complaint is made of the inefficacy of the system of disinfection and purification of these vessels at this station, but objection is raised to the having to truck cargoes of coffee a distance of 300 feet from the vessel to the warehouse (on the ground of expense), during which process such verification of the cargo is acquired as could be obtained in no better manner. I fail to see anything in the terms of the proposition of the National Board which justifies its inspector at this station to make inquiries into the expense incurred by vessels subject to quarantine regulations of this State, and still less that he should take upon himself the responsibility of advising vessels from Rio to cease their intercourse with us, and consequently destroy our commercial relations with this port.

Now, as to the expense of vessels from Rio in undergoing the quarantine at this station, they are certainly as reasonable as those of any other port where similar measures of purification, disinfection, and fumigation are resorted to; and, furthermore, this expense is generally borne by the consignees of the cargo and not the vessel, and costs about 3 to 4 cents a bag, which amount surely cannot affect the coffee market to any great extent. The inspector of the National Board of Health at this station has not conducted himself in accordance with the proposition of the body he represents, inasmuch as he has seen fit to telegraph to the supervising inspector of the National Board of Health at New Orleans the existence of a suspicious case of yellow fever at this station without consulting the State quarantine officers in reference to the alleged case, without their knowledge in any respect, and without furnishing the State board of health with a copy of the report, and which report was not justified at all by the symptoms of the case at any time being, or subsequent developments. The inspector of the National Board has on various other occasions sent reports the contents or purport of which I have no knowledge. In answer to your second question, I have to inform you the inspector of the National Board has two men in his employ, both of whom reside adjacent to the quarantine grounds.

The guests of the inspector consisted of his wife, who spent a few days here with him about two months ago, and two little girls, sisters of his wife, who have been here now about four weeks; with whose permission I do not know.

Your third interrogatory I will answer by stating that the inspector of the National Board has not, to my knowledge, violated any specific law in regard to communicating with the inhabitants of the opposite bank of the river, inasmuch as there has been no contagious and infectious disease at this station since the inspector of the National Board has been here. In answer to the fourth question, the inspector of the National Board at this station has never had yellow fever and this fact was known to the supervising inspector of the National Board at New Orleans at the time of the appointment of said inspector; owing to the knowledge that said inspector had not had yellow fever, he was quarantined five days from the time of his last communication with any vessel before being allowed to proceed to New Orleans. In reference to your last question, I believe none have had yellow fever (of his guests) excepting one of the little girls now here; however, none of them have been on board of any vessel in quarantine.

Very respectfully,

J. F. FINNEY, M. D.
Resident Physician.

NATIONAL BOARD OF HEALTH,
New Orleans, October 5, 1881.

Prof. JOSEPH JONES, M. D.,
President Louisiana State Board of Health:

DEAR SIR: Since Dr. G. F. Patton has been retired from the service of the National Board, and since I esteem him as a most trustworthy and capable officer, my sense of justice prompts me to defend one who was my subordinate from the accusations of Dr. Finney, quarantine physician, dated September 13, published on September 30, in the report of the proceedings on the 29th of the State board, and prompted by a letter of inquiry on the 6th from yourself.

Dr. Finney's charges commit great injustice by inference, omissions, and forgetfulness. No less than ten charges are made or referred to, and with each of these will be given its explanation.

1. It is charged that Inspector Patton did not restrict himself to the "terms of the proposition of the National Board of Health to the State board," to "the bounds of his duty," and to "the (superficial) object of his appointment." The terms of the proposition accepted by Governor Wiltz were, that an inspector of the National Board of Health should "be stationed at the Mississippi quarantine" for "purposes of observation and inquiry," and, as a matter of course, to report the result thereof. In my estimation, Dr. Finney entirely fails

in his subsequent charges, now to be stated, to establish any foundation for this first general accusation; and even if it were well founded, Inspector Patton simply obeyed orders to observe, inquire, and report upon everything concerning the Louisiana quarantine, whether commendable or otherwise, for which orders the National Board of Health was alone responsible.

2. Inspector Patton suggested as a remedy for the quarantine expenses incurred by vessels from Rio "that all vessels from Rio be advised by a U. S. consul at that port not to trade with New Orleans from May to November of each year." True, but Dr. Finnny omits two important facts: First, that Inspector Patton stated in the same report how this warning should be given, namely, by timely official notice to vessels at Rio and destined to New Orleans of two simple facts, viz, of the duration of quarantine detention and of the consequent unavoidable expenses. So far as concerns this latter proposition, to which the former was subordinate, Inspector Patton advocated an unquestionably sound policy, calculated to benefit commerce, viz, that all foreign ports should be given timely official notice of the quarantine restrictions existing at all ports of the United States. Second, the first proposition, that is, the suggested "warning" was not approved by myself nor by any of Inspector Patton's superiors, information thereof was restricted to the National and the State board; it never did inflict and never could have inflicted the least injury on New Orleans, and would have remained an unregarded still-birth if Dr. Finney had not preferred to honor it with a public funeral. Farther, Inspector Patton did not, as Dr. Finney alleges, "take upon himself the responsibility of advising vessels from Rio" anything whatever; he really did no more than make a fruitless suggestion to the National Board of Health which certainly is not a vessel. Inspector Patton objected to the expense of trucking cargoes of coffee to the warehouse. For what purpose? Not, as is implied, because this measure is not the best one now practicable, but in connection with his advocacy of a system for the future of sanitary barges as a substitute for the present warehouse system; the former system being calculated in his opinion to prove better both for public health and commerce.

4. Inspector Patton reported one suspicious case of fever at the station (and never but one, which occurred on the bark St. Olaf and not on the Historian as falsely reported to the board by Captain Calloway), and neglected not only to consult the State officers, but also to report the case to the State board. As to this negligence Inspector Patton frankly admitted it, and accepted censure with characteristic manliness. But this negligence though at the time unknown to me was promptly rectified so far as concerned the State board by me, for I sent a copy of the telegram forthwith to the president of said board. Not only this I sent the information in obedience to my instructions both to the secretary and to the superintendent of the Mississippi River service of the National Board of Health. Yet the panic which it had been charged would result from such a course did not ensue as is well known; on the contrary this course strengthened the confidence already felt in other States, that should real danger to them arise prompt information would be given.

5. Inspector Patton is charged with having "on various other occasions sent reports of the contents or purports of which I have no knowledge." Neither I nor Inspector Patton were ever ordered or requested to send reports to Dr. Finney, but copies of all official reports sent by Inspector Patton, and which concerned the sanitary officers of Louisiana, were sent by me to the State board.

6. Inspector Patton's two steam-launch employés resided outside of and immediately "adjacent to the quarantine grounds." Dr. Finney knows that this was unavoidable; that his own employés have the same daily communication with outside adjacent houses, and that Inspector Patton's employés were specially ordered to board no vessel without Dr. Finney's permission.

7. "Inspector Patton occasionally visited the inhabitants on the opposite bank of the river," *i. e.*, the Buras post-office. Yes, with the consent (no yellow fever being present) and generally in company with a State quarantine officer. In this I simply explain without defending, since I believe that other post-office arrangements should be made.

8. Inspector Patton entertained his wife and her two young sisters as guests "with whose permission I do not know," says Dr. Finney But inspector Patton remembers well that his wife's two young sisters had the permission of Dr. Finney, whose manly courage I have too much faith in to believe that he will deny in view of Dr. Patton's positive assertion that his own memory was probably at fault. In any case Dr. Finney has supreme authority at his quarantine station and if in this or other matter Inspector Patton acted illegally or improperly, why did Dr. Finney permit him to persist in his illegality or impropriety, such as entertaining his wife twelve days in July, and her two sisters from July 18th to September 17th, without a word of objection?

9. Inspector Patton has never had yellow fever. True he has been curiously deprived of this blessing. But he has been repeatedly exposed during four different years, and among these to the unsparing epidemic of 1878; further, he was a State quarantine officer from 1877 to 1880, and no objection was found to the misfortune that yellow fever has refused to attack him until the ex-State officer became an officer of the National Board of Health.

10. Finally, of Inspector Patton's three guests, Dr. Finney says: "I believe none have had yellow fever excepting one." The truth is that two of the three have had undoubted cases of yellow fever, and the third, 17 years of age, has been a resident of New Orleans from early childhood, had a mild fever (not known to have been yellow fever) in 1867, and passed harmlessly through the epidemic of 1878. Further, Inspector Patton enjoyed no more privilege in this matter of guests than has always been accorded heretofore to the wives, &c., of custom-house and other officers temporarily stationed at the quarantine.

Dr. Finney omits another very important fact, namely, that prior to my appointment of Inspector Patton both he and the president of the State board expressed to me their perfect satisfaction with, and their decided preference for, him. Carefully considering the charges now made against him, I find those which are well founded comparatively trivial, and recalling the numerous opportunities he has had for serious derelictions which he did not commit, I cordially thank Dr. Jones and Dr. Finney that the candidate recommended by them has been found by me worthy of their indorsement.

Dr. Finney's letter, with its attending facts (such as that his charges were not made when their causes were committed and when they might have been corrected, and that their publication was delayed to the day of Inspector Patton's relief from duty), prompt the belief that objections to Inspector Patton are altogether secondary to the far greater objection that there should in future be at the quarantine station any inspector whomsoever of the National Board of Health. However, above the minor issues which have been raised, issues readily adjustable since the National Board commands all officers to obey State authority, the questions of chief consequence to the public remain untouched, viz: Whether the presence of the inspector of the National Board of Health at the quarantine has tended to increase or decrease the vigilance which is the safeguard of our public health, and the confidence of those neighbors upon whom depends so largely the freedom of our commercial intercourse?

In conclusion, the National Board is likely to rejoice now at all such evidences as Dr. Finney presents of excessive quarantine vigilance and precaution, and to rejoice still more in future should proof be given that those who preach practice themselves and force all others, the officers of the National Board of Health included, to practice what is preached. By which remark it is not my intention to question the fact that much credit is due to the State board and to Dr. Finney for an improved and comparatively efficient, even if not as yet a perfect, quarantine. Further, Dr. Finney, as also his assistant, Dr. Wilkinson, deserve cordial thanks for their courtesy and favors to the officer of the National Board of Health, and for their invariably harmonious co-operation with him in their daily work of disinfecting suspected vessels. For them personally no feeling other than kindly is entertained.

I trust my belief will be concurred in, that justice requires that the same publicity should be given this letter as was given by the State board to Dr. Finney's.

Yours, very respectfully, STANFORD E. CHAILLÉ,
Supervising Inspector National Board of Health.

APPENDIX 8.

FOREIGN COMMERCE OF NEW ORLEANS WITH INFECTED AND NON-INFECTED PORTS.

Table showing the total value, in dollars, of the merchandise (coin and bullion excluded) involved in the foreign commerce of New Orleans, and especially its commerce with all foreign countries habitually or frequently infected with yellow fever; compiled from the annual reports of the United State Bureau of Statistics for the three years, July 1, 1877, *to July* 1, 1880, *the last report yet published.*

	Foreign countries.	1877–1878.		Yellow fever, 1878–1879—epidemic.		1879–1880.		1877–'78.	Yellow fever, 1878–'79, epidemic.	1879–'80.
A	Without the yellow fever zone.	Imports.	Exports.	Imports.	Exports.	Imports.	Exports.	Total imports and exports.	Total imports and exports.	Total imports and exports.
1	Great Britain	2,239,848	46,666,172	1,645,679	32,642,433	3,639,569	50,062,342	48,906,020	34,288,112	53,701,911
2	France	88,170	18,712,125	798,965	11,514,505	682,071	19,834,864	17,592,295	12,313,470	20,516,935
3	Russia	....	4,098,944	....	9,034,488	....	5,215,574	4,098,944	9,034,488	5,215,574
4	Germany	175,543	6,782,565	96,193	4,147,604	130,416	4,574,384	6,958,108	4,243,797	4,704,800

Table showing the total value, in dollars, of the merchandise, &c.—Continued.

	Foreign countries.	1877-1878.		Yellow fever, 1878-1879—epidemic.		1879-1880.		1877-'78.	Yellow fever, 1878-'79, epidemic.	1879-'80.
A	Without the yellow fever zone.	Imports.	Exports.	Imports.	Exports.	Imports.	Exports.	Total imports and exports.	Total imports and exports.	Total imports and exports.
5	Italy	116, 928	2, 496, 500	270, 781	1, 544, 323	284, 378	3, 114, 291	2, 613 428	1, 815, 104	3, 398, 669
6	Spain	47, 333	2, 140, 095	38, 022	1, 725, 244	553	2, 255, 680	2, 187, 428	1, 763, 266	2, 256, 233
7	Belgium	470	1, 140, 059	1, 741	664, 863	65, 113	1, 690, 010	1, 140, 529	666, 604	1, 755, 123
8	Netherlands	31, 453	1, 172, 452	1, 134	808, 758	25, 631	1, 166, 905	1, 203, 905	809, 892	1, 192, 536
9	Austria	66	109, 050		194, 273	28	514, 614	109, 116	194, 273	514, 642
10	Gibraltar		618, 282		97, 550	325	359, 207	618, 282	97, 550	359, 532
11	Sweden and Norway		425, 256	25			90, 866	425, 256	25	90, 866
12	Portugal		73, 195		11, 700	44, 304		73, 195	11, 700	44, 304
	Totals of Class A	3, 491, 811	84, 434, 595	2, 852, 540	62, 385, 741	4, 872, 388	88, 878, 746	87, 926, 406	65, 238, 281	93, 751, 134
B	Within the yellow fever zone:									
1	Brazil	4, 416, 766	6, 637	2, 160, 319		3, 366, 154		4, 423, 403	2, 160, 319	3, 366, 154
2	Mexico	1, 197, 080	707, 330	1, 052, 519	975, 502	996, 113	1, 113, 280	1, 904, 410	2, 028, 021	2, 109, 393
3	Cuba	3, 043, 697	189, 260	1, 035, 872	447, 236	1, 041, 605	262, 142	2, 232, 957	1, 483, 108	1, 303, 747
4	Central American States	81, 328	140, 310	99, 859	73, 314	135, 431	38, 395	221, 638	173, 173	173, 826
5	British Honduras	20, 536	63, 990	8, 514	48, 527	187, 698	129, 074	84, 526	57, 041	316, 772
6	British West Indies			10, 959	24, 015	10, 379	9, 038		34, 974	19, 417
7	French West Indies					327				327
8	United States of Colombia		12, 222		10, 028		11, 344	12, 222	10, 028	11, 344
9	Venezuela	1, 980	4, 749					6, 729		
10	Fr., Br., and other African ports	57	30, 940	15	17, 250	874		30, 997	17, 265	874
11	Azore, C. Verde and Madeira Islands					384				384
	Totals of Class B	7, 761, 444	1, 155, 438	4, 368, 057	1, 595, 872	5, 738, 965	1, 563, 273	8, 916, 882	5, 963, 929	7, 302, 238
	Totals of all foreign countries	11, 253, 255	85, 590, 033	7, 220, 597	63, 981, 613	10, 611, 353	90, 442, 019	96, 843, 288	71, 202, 210	101, 053, 372

The foreign commerce (coin and bullion included) of New Orleans and of the United States, compared		1877-'78.	Yellow fever, 1878-'79, epidemic.	1879-'80.
	New Orleans	96, 843, 288	71, 202, 210	101, 295, 644
	United States	1, 210, 519, 399	1, 202, 708, 609	1, 613, 770, 633

The tonnage of vessels from foreign ports entering the port of New Orleans and all the ports of the United States compared		Tonnage.	Tonnage.	Tonnage.
	New Orleans	718, 163	657, 789	760, 919
	United States	11, 530, 527	13, 772, 360	15, 240, 534

SUPPLEMENT No. 16.

National Board of Health Bulletin.

WASHINGTON, D. C., SATURDAY, DECEMBER 24, 1881.

REPORT OF THE RESULTS OF AN EXAMINATION MADE IN 1880 OF SEVERAL SEWERAGE WORKS IN EUROPE.

BY RUDOLPH HERING, *Civil and Sanitary Engineer.*

CONTENTS OF REPORT.

PHILADELPHIA, *June* 28, 1881.

THE NATIONAL BOARD OF HEALTH,
Washington, D. C.:

GENTLEMEN: In compliance with your request of May 10, 1880, and also of May 25, 1881, I respectfully submit the following report, containing the results of my examination of several European sewerage works.

Very respectfully,

RUDOLPH HERING.

I. INTRODUCTION.

The existing diversity of opinion regarding the best method of removing offal and waste-water from houses and towns can, I believe, be explained, at least partially, by certain difficulties which meet us in rightly judging the numerous methods and designs. It will, therefore, be proper at the outset to ascertain their nature and examine their bearings.

In comparing the views of the gentlemen directly and indirectly interested in the sewage question, it can be observed that the habitual engagement of the mind in certain directions tends greatly to influence opinions, and to cause what may be termed a professional bias.

It can be observed in Europe, as a rule, that chemists, physicians, and agriculturists are prominent among the opponents of the water-carriage system. They point to the injurious effects of soil contamination by sewers, of the gases and germs emanating from them, of the pollution of river and subsoil-water, and to various dangers which are expected to arise from sewage farming. On the other hand, they dwell on the manurial value of undiluted excreta, and the national importance of preventing its waste. All these considerations come within the range of their professional studies.

Again, we can notice that engineers, who find themselves confronted by problems such as the removal of storm-water from the surface of the streets, of subsoil-water and house refuse, also the construction and cleaning of streets, the supply of water to dwellings, its subsequent removal, and, finally, the restriction to the utmost economy of expenditure, are quite generally in favor of water carriage.

But, also among the latter alone, we discover a division of opinion. Municipal engineers of large cities with closely built-up districts and well paved streets, who have been obliged and accustomed to provide for the rapid removal of rain-water and the protection of cellars, &c., have generally indorsed the so-called "combined" system of drainage for all towns; *i. e.*, leading rain-water and sewage into the same sewers.

Among the engineers who have drained small towns, where usually quite other conditions present themselves, the "separate" system is often favored, where sewage and rain-water are removed in different channels; but we find it likewise recommended for all towns. Finally, even some of the details of each system form points of dispute.

An inspection of the different methods and works seemed to reveal the fact that advocates frequently lay too much stress on the advantages, and opponents exaggerate the defects of systems.*

In order to obtain a truer judgment, it is necessary to be aware of this unconscious bias and eliminate any warped opinions or relatively insignificant facts and bearings, and realize the essential features in each case.

The engineer, for instance, should be as conscious of the sanitary demands and *national* economy of his works, as his opponents should be careful to look into the nature and necessity of other city requirements, into the technical feasibility of one structure satisfactorily serving several objects, and into the question of *municipal* economy.

Judgment is also sometimes misguided by ignorance of the particular circumstances under which certain sewerage works have grown to their present state.

The financial necessity of making the best use of existing structures has often caused new designs to be quite unlike what they would have been under different circumstances. Improvements are sometimes severely criticised for this reason, although they were the best that could be done under all the governing conditions.

The physical features of a town will greatly influence the character of design, and, if not rightly understood, also give cause for erroneous opinions. The main drainage of London has frequently been attacked as being a wrong solution of the metropolitan drainage problem, yet the enormous population, the topography, the proximity to the ocean, the inexpediency and expense of a thorough purification of the sewage, quite justified the authorities in adopting the present system.

We hear the sewerage of Memphis objected to on account of the exclusion of rain-water. Yet, when considering that there was an urgent necessity of speedily and cheaply sewering the unfortunate town, this feature is fully justified, especially when considering the surface characteristics of its site. On the other hand, it would be a like error to recommend the exclusion of rain-water, or the separate system for all cities, as a few parties have advocated in England and this country.

The customs of the people can also materially influence the design, at least of details, which circumstance, if not considered, calls out an erroneous judgment. The liberal use of water, for instance, in the many restaurants and fountains in Munich, where it is allowed to run continuously to insure coolness for drinking purposes, facilitates arrangements for flushing which in other towns might be impracticable. The pail system has been unreservedly condemned by certain persons because it was found objectionable in connection with the use of water-closets, or because it was offensive from not receiving proper attention. Its efficiency for economical or other reasons where water-supply or sewerage is not available has been ignored.

Lastly, we can discover a difficulty in rightly judging the works of a city in the fact that innovations or changes are frequently resisted by those in charge either from a force of habit in adhering to old customs or from the inconvenience of altering existing laws. Although these obstacles are slight, they are distinctly noticeable, and, unless realized, often assist in warping the judgment of a particular case.

It will thus be seen that a careful inquiry into various points must be made before we can understand the numerous works and designs, and that we must be aware of the fact that some opinions are given from a sanitary point of view alone, others solely from financial considerations, or from conclusions gained in dissimilar localities to those in question.

My inspection has led me to believe that the present divergence of views is mainly due to one or more of the above causes.

The sewerage question must be treated from two aspects. As the works are to receive, convey, and discharge organic waste products, the decomposition of which is, either directly or indirectly, the cause of unhealthful influences, it is necessary to examine them first of all from a *sanitary* point of view. When a satisfactory standard in this direction can be reached, the next inquiry is into the expense attached to their execution, in other words, into the least possible *cost* at which a sanitary condition can be attained.

*Dr. Pettenkofer, the celebrated hygienist, who, at first, quite naturally, was an opponent of water carriage, altered his opinion after a thorough scrutiny of the other demands upon a city and the capabilities of engineering science.

These two considerations alone decide their merits. It will be found that several of the systems, if properly designed, constructed, and maintained, will have no serious sanitary defects, and that their relative advantages will depend mainly on the question of cost. As the latter varies with the local conditions, it is evident that these will almost wholly determine the selection of the system.

I will now briefly examine into the different methods and systems, holding the above points in view, in order to determine their relative value and applicability.

II. GENERAL SYSTEMS AND THEIR APPLICATIONS.

In general, two methods have been proposed to satisfy the sanitary stipulations: the "dry removal" and "water carriage."

The former accomplishes its object either by an immediate and thorough disinfection with subsequent removal at convenient intervals, or by temporary storage with frequent removal before decomposition can be rendered injurious, and the latter by an immediate and continuous self-removal.

The common cess-pit shall not be considered, as it, generally speaking, violates the sanitary requirements.

For isolated country houses, however, its defects will be insignificant, and where the expense for a cleaner contrivance cannot be afforded, it may be considered admissible, if not situated near the dwelling and when the contents cannot pollute any drinking water. In several European cities cess-pits are prohibited; in our own cities their use is still indorsed and, because they require the least outlay of money, are in fact the prevailing system.

1. *Dry removal.*

Among the methods for dry removal, there are but a few which can be recommended from a sanitary point of view.

Disinfection.—In order to retard, if not prevent, the escape of dangerous effluvia, certain substances are regularly added to the receptacle containing the excreta and other decomposable waste matter of the house; and the whole is removed at convenient intervals.

Two means can be employed, either absorption, by which oxidation is facilitated by the porosity of the material or decomposition and conversion of injurious compounds into uninjurious ones.

The former is accomplished by dry earth or charcoal, &c., the latter by carbolic acid, chloride of lime, creosote, &c. To render the disinfection perfect it is necessary to add the material after every evacuation and in sufficient quantities.

Although this method is efficient, yet its trouble and expense, as is easily seen, excludes it from extensive application in large cities. Yet when none other is available, it gives, with the proper materials, appliances and proper management, quite satisfactory results.

The well-known dry-earth closet is one of the best examples under this head, and the conditions under which it can be recommended are small country towns, villages, or isolated buildings, without water supply or sewerage; provided, particularly in the former case, a central authority arranges for the regular supply of fresh earth and the removal and sale of the resulting manure.

Casks and pails.—If offal is to be temporarily stored near the premises, and not disinfected but frequently removed (*i. e.*, from one to seven days), it requires to be inclosed in casks, pails, or tubs, so that a free access of oxygen and a consequent rapid decomposition, as well as the escape of effluvia, is prevented as much as possible. This method is very common in Europe, especially on the Continent, and as it has been given the preference over all others by some authorities, a short description is not out of place.

Oak or iron pails or casks, of sizes ranging with the locality and frequency of removal, are placed under the soil-pipe, which enters the lid generally with a closely fitting joint. There are two kinds in use, one receiving all excreta, the other permitting the fluids to filter through a sieve forming a vertical partition, and to flow off into a sewer. The latter, which is much used in Paris, and since June 23, 1880, has been made obligatory for all new buildings on sewered streets, is called a "fosse filtre." One-fifth of all houses in Paris are thus supplied. The capacity of the "fosse" is from 100 to 125 liters, and as it does not retain fluids it fills up less rapidly and needs to be exchanged less often. To prevent a consequent greater decomposition and dissemination of various gases, the casks should be, and sometimes are, very carefully sealed. The liquids, which are the more putrescible substances, are by this method allowed to get into the sewers, making it an intermediate step between dry removal and water carriage.

The municipal engineers of Paris, who mostly favor the latter, consider the fosse filtre an advisable transition from the common pail system (fosse mobile), which is still used by nearly four-fifths of the community, to water-carriage, because they are obliged to act subserviently to the great popular prejudice against introduction of fæces into sewers.

These circumstances should be understood, because to start anew with this device would certainly be objectionable, for it requires in addition to a system of sewers exactly like one designed to include the conveyance of fæces, the extra expense and annoyance (not to speak of the sanitary aspects) of the removal of a substance for which scarcely any money is given by the farmer, as the more valuable ingredients have been washed out. Its discharge into the sewers, moreover, would hardly be noticeable, because a great quantity of filth is already present, which is well demonstrated by the composition of the Paris sewage itself.

When the success of the irrigation fields below Paris has become fully appreciated by the inhabitants, and after they are extended so as to dispose of all the sewage (now only one-sixth is utilized), it is the intention to simply remove the "fosses filtres" and insert in their place a few lengths of pipe and thus ultimately get a complete water-carriage system.

A far more extensively used cask, one which is entirely independent of a system of sewers, is the ordinary "fosse mobile" of France, the "tonne" of Germany, or the "pail" of England. They are simple barrels or tubs, retaining the excreta, and are usually exchanged at intervals varying from one day to one week. Their contents are in a good condition to be sold and used as manure, which, when the transported distance is not too great, often allows a margin for profit on the expense for collection. When removed every one to three days in vans with air-tight doors, when well cleaned at the depot and provided with properly fitting lids and pipe attachments while in use, the cask system has no decided sanitary imperfections. This circumstance on one hand, the expense of sewers and dangers of sewer gas resulting from improper construction or management of the latter on the other, have brought out many advocates of the system, especially in Southern Germany, where it is the prevailing one and where, in some instances, it is exceptionably well managed.

To compare favorably with water-carriage systems, however, it must be restricted to—

1. Small towns, on account of the expense of cartage;
2. Towns where the regular exchange of the pails can be enforced with almost military strictness, which is seldom found outside of a few European countries;
3. Dwellings where water-closets cannot be used;
4. Localities where sewerage would be very expensive; and
5. Where the waste water can be led over the surface of the ground without causing offense.

These restrictions may often cause a close competition with the "dry-earth closet." From a sanitary point of view the latter has slightly the preference, because it disinfects the filth; yet it is more expensive on account of the additional cost, supply and removal of the earth or other substance used as disinfectant.

It will depend, therefore, entirely on local requirements and peculiarities to determine which of the two methods is more desirable.

2. *Water-carriage or sewerage.*

It is now in place to consider sewerage proper, which is a system of continuous underground pipes or channels, causing an immediate and complete self-removal of all excreta and waste water from the dwelling to the place of final disposal.

To rightly understand certain present conditions, it will be well to glance briefly at the history of the subject.

The first sewers in the more modern European towns were obtained simply by arching over the natural water-ways, which had become fouled by general refuse continually cast into them. Their position along the valley lines required a size sufficient for the conveyance of storm-waters.

After the introduction of a regular domestic water supply into cities, there was an increased supply of dirty water running off in the gutters, causing filth and insalubrity both in winter and summer; and it was proposed to lead this house-water, together with the street washings, directly into the sewers. But the improper construction of the latter caused a storage rather than a removal of the filth, and their condition, before a heavy, cleansing rain, was about as offensive as a common cess-pit. A sewer was synonymous with all that is repulsive, filthy and disgusting. Under such conditions it was suggested in England that the introduction of human excreta by means of water-closets could not materially add to the nuisance which was considered unavoidable, as the additional amount of water was enough to flush away the additional amount of floating solids, while the degree of cleanliness attained in our dwellings would be much greater than through the use of any other appliance for removal.

The idea grew in favor wherever extensively tried, and it became evident that the water carriage of excrements was rapidly supplanting dry removal.

However, the foul conditions of the sewers and their sanitary evils grew worse in proportion to the density of population. This was attributed by many entirely to the introduction of water-closets, which were accordingly opposed; by others, to imperfections in the sewers themselves. It was recognized that if water-carriage was to answer the general hygienic requirements, radical changes were necessary in design and construction to prevent deposit and storage of filth. Investigations were therefore made with reference to grade, shape, &c., to facilitate a complete and rapid removal, and enough was learned to see a practical possibility of attaining good sanitary conditions. Then, as it was found that most of the old existing sewers could not be made to answer the new demands, mainly on account of their shape and grade, it became a question of economy whether they should be entirely replaced or used for a purpose less exacting. This circumstance gave origin to the "separate system," when rain-water alone

flowed into the old sewers, the house drainage being led away by a new system of very much smaller pipes. A small amount of rain-water was turned into the latter from back roofs and yards, in order to give them an occasional flushing. When, however, no old sewers could be systematically utilized in this way, and the rain-water removal was an important consideration, we find that the "combined system" was adopted, leading off rain-water and sewage by the same channels, as in the larger cities of Europe and here.

Another phase of the question now appeared. The extension of sewers increased the amount of filth discharged into the rivers, causing a pollution of perhaps the only available source of drinking water for other towns. This new trouble was mostly felt in England, where the population is dense and the rivers are small, and where it consequently has attracted the greatest attention.

Unless the "pail system" could be resorted to and restrictions placed on the quality of water led into the old sewers (which was done in the towns of Rochdale, Halifax, &c.) a sufficient purification of the sewage before discharging into the rivers became the only alternative.

Great efforts were made to discover an efficient process, and they were encouraged by extravagant hopes of gaining a valuable manure. Views differed greatly and much discussion was elicited. Yet enough experience has been gained to indicate a fair solution of the problem.

The original expectations have been well sobered down and the question resolved itself into the endeavor to obtain a sufficient purification at the least cost to the community, instead of expecting a large profit. Not one but several methods are found to give good and economical results, and their respective advantages depend on local conditions which require careful consideration in each case.*

The last obstacle which prevented the water-carriage system from answering every hygienic and economic requirement seemed herewith to be removed. Yet there are still a number of prominent men, especially on the Continent of Europe, who are active in their endeavors to hinder its adoption, notably Dr. Alex. Müller in Berlin, Dr. van Overbeek de Meijer in Paris, and Dr. L. Winterhalter in Munich, chemists and hygienists.

In scanning their elaborate arguments, however, a marked professional bias is observable, and possible hygienic deficiencies in the water-carriage system seem to be greatly magnified, whereas important technical questions are wholly ignored or misrepresented and, on the other hand, they have commended substitutes for these cities which for engineering or financial reasons are objectionable. Decomposition and imperfect ventilation in sewers, soil and river pollution are judged from badly designed or old works, which modern engineers also condemn, and the best constructions are thought exceptional or are not given any consideration. On the question of sewage disposal, they also magnify the defects but overlook the benefits and gains. On the other hand, essential points have often been practically ignored by municipal engineers. These should appreciate the real aim prompting such attacks, and realize the dangers to which they may expose communities by improper and careless work, thus constructing new and easy means of propagating and disseminating germs of disease. The superficiality with which some sewerage works have been built, often in our own country, is appalling, and furnishes critics with abundant material, which is frequently used against the system itself.

The present time furnishes the engineer with enough experience and facilities, as I believe from my inspection, to economically design, construct, and maintain sewerage works which can effectively satisfy the just demands of sanitarians. If this is to be the conclusion, it must on the other hand be based on the condition that engineers pay greater attention to these demands, and not ignore the fact that they are the *prior* claim which the works should satisfy.

Also for dwellings, where sanitary precautions are even more important than in the streets, water-closets are preferable to the best-managed dry closets, because a much greater degree of cleanliness can be attained. Therefore, if all other governing points are equal, water-carriage should always be recommended *versus* dry removal. But the rapid and continuous flow of water-carried sewage from its entrance into the sewers to its final outfall forms the chief claim of superiority over the dry removal.

The remaining point of comparison is the cost. It has already been stated under what circumstances dry removal will be most economical, which implies to a certain extent the conditions under which sewerage is to be preferred. These can now be directly stated as follows:

1. Where a regular water supply in sufficient quantities is furnished to the dwellings, this being the most essential condition.

2. Where waste water is sufficiently abundant and foul, and therefore requires rapid removal to a distant point, which will usually follow the former condition, especially in large towns.

3. Where the population is dense, which relatively decreases the expense per inhabitant.

4. Where the topographical features and location of the town do not require an unreasonable outlay of money. Water-carriage would, for instance, not be economical in small towns, on very steep and irregular slopes, with bed-rock near the surface, or where the site is a long, narrow strip along the shore of a large river, when the expense of sewerage would be out of proportion to its benefits over the dry removal.

5. Where the disposal of sewerage offers no great difficulties or expense. It is questionable, for instance, whether sewerage could be advised for an inland town having a very cold climate and where, from the absence of a large river, its sewerage must be purified.

6. Finally, in general, where the interest of the amount invested in sewerage will be smaller than the cost of dry removal, provided the latter is kept up to a sanitary standard. This condition will cause the advantages of water-carriage to increase with the size of the cities, but the exact point beyond which sewerage is cheaper than dry removal can only be determined from the local peculiarities.

After these remarks, applying to water-carriage in general, it is now in place to examine into the ways by which it has been effected; and here, too, we are met by a variety of opinions.

In the main there are two systems, as already mentioned, the "combined" and "separate." The latter is again subdivided, on account of different views, into the Ordinary, the Shone, and Liernur systems.

Combined system.—The characteristic feature of this method of sewerage is that it serves the double purpose of removing sewage and rain-water by means of the same sewers. In tracing its origin it was found that the underground removal of rain-water in densely populated cities was considered necessary even before a regular flow of sewage was created by the introduction of a regular supply of water; and at the present day, when the built-up districts are even larger and the pavements are better, which allows a more rapid concentration of rain-water in the streets, this underground removal in large cities is even more necessary.

Further, it has been found in London* that during a rain the first wash from the streets is likely to be as foul as ordinary sewage, and therefore it is proper, especially when they are not well cleaned, that it should be led into the same channels.

The combined system, therefore, consists of a net-work of sewers, having a sufficient capacity for the removal of storm-water in addition to sewage, and having inlets for its reception along the streets as well as in the houses and yards. To prevent heavy substances, such as sand, from entering the sewers and silting them up, catch-basins are attached to the inlets whenever deemed necessary. To prevent gases, caused by the decomposition of sewage, from disseminating where they could be injurious, traps are inserted near the inlets in the houses or streets. Yet to enable them to escape at proper places means of ventilation are provided by untrapped pipes terminating above the roofs, by chimneys, or stacks, and by open gratings at intervals in the roadway.

The disposal of the sewage is attained either by leading it directly into large rivers, or by means of intercepting sewers which collect the sewage alone and let the rain-water flow into the nearest water-course, carrying the former to a certain locality, where it can be purified. Access is had to the works by man-holes at convenient intervals, and appliances for flushing are attached wherever necessary.

To determine the merits of the combined system it is necessary again to examine it, first, from a sanitary point of view, and then with regard to its relative cost; and in doing so, it is premised that the works are well designed, well executed and maintained. Its sanitary advantages may be said to be as follows:

The periodical conveyance of large quantities of storm-water through the sewers has a cleansing effect, such as would be expensive to obtain artificially in even much smaller sewers. In some cities, mostly in America, this is the only means by which sewers are cleaned. However objectionable the omission of further cleaning is, it cannot be denied that storm-water flushing will always be a powerful agent to maintain the sewers in a sanitary condition, and should be made use of wherever other circumstances will permit of it. A concomitant advantage will be the removal of the dirt and filth from the surface of the roads, unless the street cleaning is otherwise efficiently attended to. In Paris it is even found preferable to wash this dirt into the sewers at ordinary times,† which enables the streets to be rapidly and well cleaned, and the transportation of the silt by the sewage, aided by the "bateaux and wagons vannes," with subsequent removal at the outlet, is but little more expensive than carting it on the surface. The large size of the sewers for rain-water removal greatly facilitates inspection and cleaning, compared with those which convey sewage alone, and also greatly decreases the possibility of an obstruction. In spite of careful precautions, substances which, theoretically, are to be excluded, will get into sewers. Grates are accidentally or willfully lifted up, and articles, such as cans, scrubbing-brushes, old clothes, and dead animals, have been introduced and subsequently removed as the cause of stoppages.

As the combined system is a single one, it facilitates the management and, therefore, increases the probability of having proper attention given it. When two systems of sewers are found in the same street, it has often occurred that connections have been made to the wrong sewer, which partially defeated the object of the "separate system." This difficulty is stated for England in the "Suggestions of the Local Government Board," and it would be still greater in our own country, where municipal affairs are less strictly managed.

The sanitary objections to the "combined" system, as given by the advocates of the "separate" one, are as follows:

The difference of velocity during rain storms and at ordinary times is liable to cause deposits after the storm is over, when the rapid flow is checked and the suspended particles are precipitated. The

* See VI. Disposal of sewage.

* Analyses of street-water by Professor Way, London.

† There are no catch-basins to the street inlets in Paris.

latter is also sometimes aided by a decrease of grade in consequence of a larger size of the sewer. This objection, although valid in some cases, cannot be made to rightly designed sewers. Deposits are prevented to a great extent by giving the sewers sufficient grade to allow the *ordinary* flow to move the silt which usually gets into them, and not relying on the mean velocity of the storm-water to accomplish this purpose. Deposits can also be often avoided by an egg-shaped section, in which the invert radius is about as small as the radius of a semicircular section just filled by the ordinary flow.

Another point of attack has been the slimy decomposing coating (in German, sielhaut) sometimes observed on the sides of the sewer, which is formed by the adhesion of particles floating on the rising and falling surface of the sewage. The objection is made chiefly from the anti-water-carriage stand-point, but it applies more to the combined than to the separate system, where the change in the surface of the water is not so great. This filthy coating may undoubtedly at times cause injurious emanations, yet it can practically be prevented by a regular flushing of the sewer, and also by giving the interior a smooth surface, which does not readily permit the adhesion of floating matter. A smooth surface is advisable also for other reasons, as will be seen later.

Further, it has been said that flushing cannot clean large sewers as well as small ones. This is true under certain conditions; mainly, when their designs are faulty and less care is given to their maintenance. If the cross-section of the flowing sewage is a flat segment, flushing has not the same power as when it is semicircular. An egg-shaped section, so proportioned that the invert gives to the daily flow of sewage approximately a semicircular section, will permit of the same flushing effects as a pipe of corresponding size. The only important difference then is with reference to the coating on the sides, which is more extensive in the combined sewers. The smaller pipes can be entirely filled by a much smaller quantity of water, and therefore this coating can be more readily prevented. But this advantage, though important, has yet been much overdrawn. Without greater cost large sewers can be cleaned to a degree which cannot be objected to, as many existing works, especially Frankfort and Hamburg, sufficiently prove. If the water or sewage is dammed up by penstocks and used in greater abundance, the effect is quite satisfactory. The velocity of the flushing water depends more on its head than on the difference between the sections. In smaller sewers the same quantity of water can be maintained at a greater head than in larger ones, where it sinks more rapidly.

In Paris fæces are kept out of the sewers because, it is said, they cause the offensiveness and danger of sewer air, and, as men are constantly engaged in flushing and cleaning out the silt, are therefore objectionable. But experience does not prove such an effect of fæces alone. The air in well-built sewers, with complete water carriage, is not at all offensive on this account. In the sewers of Frankfort and many other places the air is not only equal to but even better than that in the Paris sewers, where it has several itmes occurred, from want of sufficient ventilation, that men have been suffocated.

The question of ventilation next demands a few words. It is said that large sewers contain a greater quantity of impure air, but impurities emanate primarily from the sewage, and their quantity stands in relation to it, instead of to the air in the sewer. If the sewage is decomposing and foul, the air will be worse than when the sewage is fresh; and a certain amount of impurities arising into the air will evidently pollute it more in small and less in large sewers. It is further given as an advantage of the former that the entire air can be more readily exchanged in small sewers. Yet, as it is more foul in them, a more frequent exchange is necessary. Dr. Buchanan states* that noxious germs in small sewers produce a more intense poison than in large ones, and that small sewers need the more frequent openings for ventilation.

The impurities reaching the atmosphere from the same quantity and quality of sewage will be practically the same whether the sewer is large or small. But this supposes the inner surfaces to be tolerably clean, as they should be and are in most of the sewers that I saw in Europe. When covered with a thick film of slimy matter in perpetual decomposition, it will affect the air contained in a sewer more than the fresh sewage. Yet, also from this cause, the size itself is not necessarily objectionable. The air will even be less polluted in a large than a small sewer, other conditions equal, because its quantity increases as the square of the perimetrical surface. However, when the sewage is fresh and flowing rapidly, and the total amount of impurities generated depends more on the extent of the slimy surface, if such exists, it is evident that, irrespective of the degree of pollution, this total amount will be greater in a combined sewer. The interior surface must, therefore, be in a reasonably clean condition, if the air escaping from the two systems under like conditions shall be of like quality. That this is neither difficult nor expensive to do, was proved to me by the inspection of many rightly-designed sewers in the cities I visited.

The ventilation of large sewers through house-pipes, it has been said, is very imperfect and uncertain. This is true when it is connected with ventilation through *openings* in the street. The friction in the long pipes and the fact that matter is discharged through them in a downward direction, will greatly hinder an upward draught, whereas an opening in the street immediately permits exchange, except when covered with snow.

Objection has also been made against the combined system on account of the inlet-basins along the streets, which frequently emit odors as bad as badly-kept sewers themselves. Without entering further into the question of inlet-basins at present, it may simply be stated that if rain-water at all requires underground removal, this objection holds equally good against the separate system.

Finally, it is claimed that when purification of sewage is needed its separation from rain-water is necessary. This conclusion can only be conditionally admitted. If the storm-water, when it is but slightly mingled with sewage, is objectionable in a stream on account of the future use of the water, it will be best to keep them entirely separated. There will be more cases, however, where the conditions do not make this total separation necessary. A slightly increased bulk of sewage delivered on farms or works for purification during storms, is not always objected to if confined to the first wash off the streets, &c., which is not much cleaner than ordinary sewage. On the other hand, it is also generally permissible to let a slight amount of sewage flow into the river together with a large amount of storm-water. The size and character of the river and the use to which its water is to be put thereafter will determine the amount of sewage which can be admitted in this way, and therefore the advantage of separation. And here a usual tendency of criticism must not be overlooked. While no objection is made to a slight amount of impurities discharged into rivers from natural causes, great objection is sometimes made to the same degree of pollution when it is permitted or caused by works which were constructed to prevent a much greater degree of pollution. The storm-water which is discharged by the sewers after the first surface wash has been intercepted, will not differ materially, if at all, with regard to the amount of organic impurities it contains, from the water which enters the river from the separate rain-water sewers when they have been dry for some time, and from the surface of towns and fields after a drought.

The case, however, which needs a close inquiry in this respect will not be the effect of sudden and heavy storms, but of light and long rains. The sewage reaching the purification grounds from a combined system will be diluted for a longer time, and the overflow from intercepting sewers will be proportionately more polluted as the intensity of the rain is less. Only the locality can furnish the deciding elements on this point.

The objections that have been made against the combined system on sanitary grounds are, therefore, only substantiated when it is imperfectly designed, built, maintained, or applied—difficulties to which the separate system is also exposed, and perhaps from its greater complexity in some cases even in a greater degree. When purification is needed it will depend on the local conditions whether the combined system with interception of sewage is to be avoided, but not on any general defect of the system itself.

If from a sanitary point of view the method of leading rain-water into the same channels with sewage is not necessarily objectionable, it only remains to inquire whether the expense of so doing is greater or less than by separation.

The great variety of conditions, topographical, physical and social, including the cost of proper materials and labor, make it impossible to do more than to indicate their relative expense in very general terms, together with the directions in which the economy of the two systems is most distinctly seen. Nothing but a careful local estimate can in many cases decide which is less costly.

The expense of a sewerage system does not merely include its first cost, but also its annual cost for maintenance. As the latter represents the interest on a certain capital, it should be carefully considered in a comparison.

When systems are compared financially it should be done with regard to the objects they accomplish. The combined system can naturally only compete with the separate, in cases where both sewage and rain-water alike are to be provided for. The cost of Liernur's system has been advantageously compared with that of the combined, while the former did not provide for any rain-water removal either on or below the surface. The question is, which system accomplishes the same purposes at the least expense? Just as account was taken of the removal of waste water in comparing dry removal with water carriage, so must the removal of rain-water be accounted for here.

When separate sewers are built for storm-water alone and are proportioned for the same amount as a combined system, they alone will cost nearly as much as the latter. A saving of expense is obtained by less depth of excavation in many places, and consequently, also, more grade and a smaller diameter. The cost of the system for sewage alone will be additional and generally be much greater than the saving effected on the rain-water sewers, even if built in the same trench. Although nothing but a special examination will determine it, yet it can be said generally, that the cost of *two* sewers to accomplish the same object as *one*, will be greater.

To draw a general comparison regarding the cost of maintenance is more difficult. The combined system can more easily be inspected and cleaned, on account of its greater size, than the separate sewage-pipes, and if properly designed is less likely to get entirely obstructed by accumulations. Sometimes, however, it may be consid-

* Report of Medical Officer of the Privy Council, 1875, pages 47 and 48.

ered an advantage to let a slight amount of deposit obstruct the channel, and in thus giving warning cause it to be removed, while in a larger sewer it might remain unnoticed for a much longer time. The fact that there is only one set of sewers, and therefore less length to be inspected for the same area, will also reduce the cost of maintaining the combined. The expense of flushing the two systems will not vary greatly, provided both are designed and constructed equally well and cleaned in the same manner. The combined system has an additional advantage of the scouring effect of heavy rains, which, in many of our own cities furnishes the only means by which a cleaning is effected.

From these points it can be concluded that the economy of a combined system over a separate one depends mainly on the following conditions: Where rain-water must be carried off under ground from extensive districts, and when new sewers must be built for this purpose, it will generally be cheaper. Its cost will also be favorable in densely-inhabited districts from the circumstance that the proportion of sewage to rain-water will be greater, and therefore increase the sizes of the separate sewage-pipes, yet without decreasing those of the rain-water sewers; while the sizes of the combined would not vary with the population, because the quantity of sewage is less than the quantity within which the amount of storm-water can be estimated.

But more important is the fact that in closely-built-up sections the surface washings from slight rains would carry an amount of decomposable matter into the rain-water sewers, which, when it lodges as the flow ceases, will cause a much greater storage of filth than in well-designed combined sewers which have a continuous, flow and generally, also, appliances for flushing. In cities which give every indication of rapid growth these points become of importance when deciding upon a system.

Separate system.—The separation of sewage from rain-water by leading them into different channels originated, as already mentioned, from causes which were mainly financial. Where existing sewers could be made use of for rain-water conveyance alone, very much smaller pipes only were necessary for sewage; and where proper and complete purification of sewage was very expensive, it was advantageous to prevent it from being occasionally increased even by a small quantity of rain washings from the surface.

The old sewers being incorporated into the new system with slight alterations and extensions, naturally reduced the cost of the entire works very materially. It was then thought, as the sewage was found to be effectually removed in the small pipes and, on the other hand, many if not most of the large sewers showed accumulations of house filth, that the separate system had inherent merits on sanitary grounds.

Among those who are advocating the principle, there is some disagreement as to the design by which it will be best accomplished. Several systems are proposed, the distinguishing features of which are briefly described as follows:

The *Ordinary separate system* as used in England consists of a pipe-line extending into each house, there to receive the house drainage, generally with an admixture of some rain-water from the yards and back buildings. The rest of the rain-water, where it cannot flow off in surface channels, is carried off through separate sewers. These may be quite shallow, as their only object is to remove the water from the surface.

The details of the former are substantially like those of the combined system. The only differences are in their shape, which is circular, on account of the regularity of flow, and their size, which is very much smaller. There are also no street inlets connected with it. The details of the rain-water system are also substantially like those of the combined, excepting their depth, and in most cases the absence of connections, except from street inlets. In shape and size there is no material variation. Man-holes for inspecting are required for both lines of the system, and flushing arrangements, absolutely necessary in the sewage-pipes, may be omitted in the rain-water channels, if they are well constructed.

The object of leading some rain-water into the smaller pipes intended for sewage alone is mainly to get the advantage of an occasional heavy flush. The self-acting flush-tank, recently invented by Mr. R. Field, has been proposed as a substitute for this irregular cleansing, as well as for the flushing by human aid. It has been quite successfully applied in England, notably at Aylesbury. The necessity for introducing any rain-water into the sewage pipes is, therefore, dispensed with in using this regular means of flushing. Experience is too limited, however, to determine the range in which it will be useful and advantageous over other modes of flushing. And it will depend on this experience whether it is wise to exclude all rain-water from the sewage-pipes or not.

Shone system.—A substantial variation from the ordinary separate system has recently been proposed by Mr. I. Shone, of Wrexham, for localities where sewage for one reason or another requires a frequent lifting.* Self-acting sewage ejectors are distributed over the district and operated by compressed air supplied from a central station. The sewage runs into an iron container, holding from one to two cubic yards, and is then automatically ejected and lifted to any desired height. The advantage of this class of pumps consists in lifting small quantities at any number of convenient points, so that it can continue its course each time in shallower sewers and with better gradients. The economy and convenience of compressed air for transmitting power to long distances, in comparison with steam, makes the principle a practical one.

As the system has not yet been in operation, except for trial purposes on a small scale, it is not possible to determine its future value with certainty at present.

Liernur system.—Another variation of the separate system, and one which has already had extensive trials, is proposed by Captain Liernur, of Holland. In its original form, it should hardly be classed under water-carriage systems, and even now the matter which it is intended to remove is rather suspended in water than carried by it. Yet the character of the sewage and the entire works themselves are so similar to what is given under this head, that an absolute distinction is not warranted.

Its origin can be traced to the cess-pool system. In several cities, notably in Paris, the closet refuse was, and still is to some extent, passed into a water-tight pit, from which it was removed at intervals in the following way: A large cylinder, from which the air has been exhausted, is placed on a cart and taken to the premises. A tube is connected with the pit, a valve opened, and the contents of the latter are forced through the tube into the cylinder by atmospheric pressure. Isolated houses not connected with Liernur's system of pipes are still treated by him in this way in Amsterdam. The uncertainty of the vacuum after reaching the dwelling or the loss of power when the contents of the pit do not fill the cylinder have made it preferable, either to exhaust the air by means of a pump on the premises, as is extensively done in France, Germany and our own country, or to lay the tube permanently under ground, from each dwelling to a common tube and thence to an exhausted cylinder in a central position.

The latter is substantially the Liernur system. It was proposed to dry the matter by waste heat from the engine and obtain a valuable manure. The use of the water-closet and the unpreventable addition of some waste water have virtually made the sewage so dilute (50 parts water to 1 part solids) that the expense of evaporation has caused this idea to be abandoned.

The present system, as used in four or five towns in Holland, may be briefly described as follows: The excreta drop into an ordinary hopper-closet, which is ventilated from its upper edge by a pipe leading to the roof. Water is permitted for flushing, although there are restrictions as to its quantity. Under the closet is a trap from which the matter drops into a vertical soil-pipe, and then passes horizontally to the "barometrical" trap and on to the street mains. These unite in an underground iron reservoir, sufficiently large to hold the excrements from the number of buildings in connection with it, and provided with necessary stops and valves. From here a delivery-pipe leads directly to the central station where the air-pump is situated, and where the sewage is run into barges and taken away to the place of final disposal.

The "barometrical" trap is an important feature in equalizing the air pressure at the many houses and in regulating the exhausting of the sewage, the quantity of which is different in every branch. It is simply a running trap with its depth a constant quantity in every case, which enables the vacuum, created in the main, to draw the sewage from all branches until in every one there is only enough sewage left to seal the trap. The difference of water-level on its two sides then measures the pressure against the vacuum, and, if the latter be further increased, all traps would be simultaneously drawn. It is thus possible to prevent a destruction of the vacuum by one pipe becoming emptied before the rest. The operation of the system is not complicated.

The air in the various reservoirs and in the delivery-pipes connecting them with the central station is exhausted by an engine, stationed at the latter, to a vacuum of about two-thirds of an atmosphere. Then a valve connecting the reservoir with a main is opened and the contents of the latter are forced into it with very great velocity. In this way, after the air from the reservoir has again been exhausted through the delivery-pipe, a second main is emptied, and so on until the reservoir holds the sewage from the district which it serves. The delivery-pipe is again exhausted, and now the entire contents of the reservoir, on opening the valve, rush to the central station. The whole operation consumes thirty minutes, and requires but one attendant.

The length of a main is about 800 feet, which relieves, in Amsterdam, 80 branches for about 160 soil-pipes. The pipe lines are all iron, 5 inches in diameter, whether branch, main, or delivery; and experience has shown that they remain air-tight, and that no permanent coating decreases their capacity. The system has been in use since 1871.

As far as described no provision has been made for the removal of any substances but the excreta and toilet-water. All other waste fluids from houses, factories, and streets, together with rain-water, are to be led into another system of underground pipes, like ordinary sewers. Although this has not yet been executed, nor is it contemplated, it will be easy to see that the design and extent of these sewers cannot differ materially from the combined system itself. At present the rain and waste water run partly over the surface and partly through old sewers into the numerous canals and water-courses peculiar to the towns in Holland.

* I. Shone: Scientific and Sanitary Drainage. London, 1881.

I will now enumerate the sanitary aspects of these separate systems and examine into their relative cost, and in doing so it is best to first consider the general question of separating the sewage from rain-water, and then the special designs.

The main advantage claimed for the separate system is for the case when purification of the sewage becomes necessary before entering the streams, because the sewage is kept more uniform in quantity and quality. It is maintained both that storm-water should not be polluted by city filth, and that sewage should be kept free from rain.

Regarding the two latter points, opinions differ among the advocates of the separate system itself as to their relative importance. Monson insists on the former, in order to preserve the purity of the rivers, and considers the latter of minor importance, if kept within reasonable bounds. Waring insists upon the latter, but considers the former less important. These questions have already been partially considered under the combined system, and they may now be briefly answered to the effect, that when the streams cannot bear the introduction of any polluted storm-water running off from the surface of the town, then a preservation of its purity will need most attention, and the dilution of the sewage is secondary in importance. When purification of the sewage is difficult, and often when pumping is required, then only is a restriction to its dilution by rain-water of more importance.

From these cases it will be seen that the advantages claimed for the separating system, as such, are based on the conditions of the locality requiring drainage.

Objections to the separation of rain-water and sewage, some of which have already been mentioned while considering the combined system, are as follows:

Small pipes increase the possibility of stoppage and disorder, slight and almost unavoidable imperfections at their joints, either original or from settlements, being mainly the cause. Wherever small pipes have been used these obstructions have occurred, and when they occur are more difficult to remove. In general, small sewers are more troublesome to inspect and to clean.

Although ground for these objections exists, they are mainly based on cases when the sewers have either been improperly built, with regard to design or workmanship, or carelessly maintained by neglecting inspection or flushing. The enormous extent to which pipe-sewers have already been successfully used, particularly in England, shows that the above objections cannot be made to small pipes as a principle, but only to imperfect management.

Regarding the double system, it has been objected that if not absolutely tight the pipes will act on each other under the street and so defeat the object of separation. Connecting houses with the wrong sewer has done the same. But such objections are based on imperfect work and imperfect supervision, both of which may have as troublesome consequences in the combined system.

The channels receiving the rain-water alone are said to be about as foul as ordinary sewers, and if this is the case separate sewers are hardly justifiable. This objection is only valid when the sewers have comparatively flat bottoms, when the streets are not well cleaned and much filth is washed underground and left to decompose. Good construction and maintenance will avoid the objection. But without this care my inspection has convinced me that separate rain-water channels, receiving the surface drainage of streets and the filthy accumulations of catch-basins, differ little from combined sewers. And if they are to answer sanitary requirements equally well, they can also not differ much in design.

The extent of the surface from which rain-water is to run, either into the sewage-pipes, the separate channels, or to remain on the surface, is differently advocated. Some sewage-pipes receive no rain-water at all, some only that from the back roofs. Some, in addition to this, receive the water from the back yards, possibly in places making up nearly the entire block, or about one-half of the built-up area, allowing the other half, mainly from the streets, and which is as polluted as the water from roofs and back yards, to run into the rain-water channels. The disadvantage of this feature, unless the latter are carefully looked after, is apparent.

To prevent the street-wash from fouling the separate sewers, and to use it for flushing the streets during storms, and also to reduce the size of the sewers, it has been proposed to keep it on the surface as much as possible, if not altogether, and to let only the rain-water from the blocks enter them, which, as the latter furnishes much less cause for fouling them, is undoubtedly an advantage. But, in comparing the cost, it must be considered that the expense saved in keeping the street-wash on the surface must be proportionately applied to the combined system, where this can also be done, although from a sanitary point of view it signifies nothing to turn the street-wash into a sewer where already much greater impurities are being conveyed.

It appears, therefore, that neither are the objections to separation serious nor the advantages great, except in certain cases where purification is difficult and the pollution of rivers feared.

Regarding now the comparative cost, the separate system is said by its advocates, especially those claiming patents, to be much cheaper. When rain-water can as conveniently and safely be led off on the surface, there is no need for the combined system; and its cost, mainly due to storm-water removal, should not be compared with that of only a part of the separate system. The general question of comparative cost, with this view, has already been considered. It is therefore only necessary to restate the main points briefly, and to add such as were not mentioned before.

When sewage requires pumping it adds a certain permanent expense, which varies partly with the amount of sewage to be lifted. It is therefore economical to reduce this quantity as much as possible, especially when the lift is a high one; and in this case the separate system, which excludes the storm-water, may become preferable on this account.

When storm-water can be led into old existing channels which are unsuitable for the conveyance of sewage, but which can be repaired and sufficiently extended at no great cost, it is evident that the expense of constructing new sewers for sewage alone will be much less than if a new combined system were built.

When it is necessary to build a system of sewers for house drainage, with the least possible delay and cost, the separate system will likewise be more economical, if the rain-water removal is not a pressing question and can be postponed to a future day.

When rain-water can be led off in a few valley-line sewers, it will sometimes be more economical to keep it separate, by leading it into shallow channels, thus saving excavation and often getting a better grade to the outfall; or, the rain-water alone, after leaving the central parts of the town, may then continue its course even in open channels. In small towns the latter is often possible.

When all the rain-water can flow off on the surface of the town without inconveniencing traffic or flooding cellars, it is not necessary of course to lead it off underground in expensive channels. A combined system then reduces itself naturally to a separate one, which becomes the most economical.

A duplicate system for a large, closely built-up area, where the rain-water sewers require to be equal in extent and size to the combined system itself, has never yet been carried out, although occasionally advocated on sanitary grounds. That the cost of such a system would be greater under otherwise equal conditions seems beyond a doubt.

A second set of private drains for each house is expensive and could not well be enforced in poorer quarters. From small premises the rain-water could always run over the surface until it gets on the street. In fact, it would hardly ever cause trouble, if the rain-water falling on each block, which virtually is a summit, and where a large quantity of water can not accumulate, would run on the surface to the street, and from there be led underground.

A few general comparisons with reference to the cost of maintenance have already been given, and it was concluded that inspection and cleaning were more readily accomplished in the combined system, but that it may be considered an advantage of small pipes that they give an early warning of accumulations which can remain unnoticed in a large sewer for a much longer time. It was also said, as there was less length to be inspected for the same area in the combined sewer, that the cost would be less; but it must be added that this will only be the case when the same amount of rain-water is removed subterraneously in both cases. To properly maintain a pipe-sewer alone will generally not cost more than, nor even as much per lineal foot as a large sewer discharging the same amount of sewage.

The principle of separation, therefore, although often ostensibly preferred on sanitary grounds, does not necessarily give the system in this respect any decided advantage over the combined, except under certain definite conditions. Under all others, preference will depend on the cost both of construction and maintenance, which only a careful estimate, based on the local requirements, can determine.

After having reached this general conclusion, it will now be necessary to examine into the special designs and to state their several advantages and disadvantages, both with reference to the combined system and to each other, as far as pertinent to the question.

The *ordinary separate system* is the most extensively used and advocated among those under this head; and its special sanitary advantages (some of which have already been alluded to under the objections to the combined system) are claimed to be as follows:

The pipes conveying the sewage alone can, from their smaller size and better grades, be more thoroughly flushed, and therefore contain less deposits and no extensive slimy coating. In short, they can be kept cleaner. The flow is more regular, and the velocity more uniform, which makes it less likely to deposit heavy silt, as in the great change of velocity during and after a storm. Small sewers are more readily filled by a flushing stream, and this can usually receive a greater head for the same amount of water, both of which very much increase its cleansing effect. These points, among others, are brought out prominently by the advocates of the separate system in arguments to show its great superiority over the combined. A closer examination, however, will show that the results obtainable are in some points only slightly better and in others not necessarily so. A bias is here undoubtedly observable. The fact that there are direct personal interests concerned in several of the systems brings them out more prominently, and it is also observable that those who advocate them exclusively are generally not concerned in directing, managing, nor are always thoroughly familiar with the engineering questions in a large and populous city. The advocates of the separate system usually ignore the practical possibility of making large sewers as perfect sewage carriers as small ones, basing their opinions on perfect works in this case and imperfect ones in the other.

An actual and extensive inspection cannot but reveal the fact that the above points give only slight advantages, if at all noticeable, over properly designed and constructed combined systems, and also that the latter can readily be kept as well cleaned as is necessary.

This can be particularly noticed in Frankfort, Hamburg, and the newer sewers of London, Liverpool, and other English cities, in which the air before and during flushing was not found to be very offensive—no more so than in Reading, Oxford, and other towns using the separate pipes.

The removal of any heavy silt, deposited by storms, can in almost all cases be effected by regular flushing. If the sectional shape of a combined sewer is such that the ordinary sewage can flow in a semi-circular channel equal to that given to it in a separate sewer, the advantage of the latter will greatly diminish. By an egg-shaped form, in which the invert radius is not larger than that of the pipe sewer, this condition is approximately reached, and the egg-shaped sections should be so designed.

The advantages claimed for better flushing are partially for the same reason not much greater. The scouring effect in the same semi-circular channel cannot be very different. Flushing under a greater head in one case is nearly equaled by the facility of penning up a greater quantity of sewage with which to flush in the other.

The reduction of the area covered with a slimy coating, as compared with larger sewers, is an advantage of small ones which can be met in the former by smooth surfaces and extensive flushing.

The absence of great changes in velocity caused by storms, and hence of heavy silt deposits, is also given as an advantage of the separate system, which, however, can also be met by more powerful flushing in the combined.

It is further claimed that the ventilation in small sewers can be more thorough than in large ones. While considering objections to the combined system, this question was examined, and it was found that the impurities reaching the atmosphere from one system will be practically the same as from the other if both are well maintained, yet with the odds against the combined. It may here be added that the friction of air will be greater in smaller pipes, by which the circulation is relatively impaired. The downward motion of the water will tend to draw the air downward, whereas warmer air in the higher portions or in the house pipes will tend to draw it upward.

The assertion that house pipes will better ventilate a small than a large sewer is only true when no other means are provided. Openings in the street will offer less resistance to an exchange of air than long house pipes, and therefore will effect it first.

As the circulation of air in a large sewer depends on its relative temperature and pressure, it is evident that its bulk is not as readily replaced as in small sewers, where the flow of sewage in the warm seasons also facilitates this exchange. Therefore as the total quantity of air in a large sewer contains as many impurities as the air in a small sewer under normal conditions, they can be more readily removed in the latter, although not diminished in quantity.

A claim that the separate system will reduce the death-rate more than the combined has not yet been substantiated. If it is difficult to trace the direct influence of sewerage works in general on reducing the death-rate, on account of the numerous other influences, it is still more difficult to trace a difference in the influence of either system. Philadelphia, which has a very inferior system of sewerage, has a death-rate of about twenty. In New York, where it is much better, the death-rate is twenty-six, and in Memphis, where the sewerage is still better, the death-rate is about forty.

The unfavorable criticisms against the ordinary separate system can be summed up as follows:

Unless there is a water supply abundant in quantity, constantly available, and under pressure in every dwelling, the separate system will be much more liable to give trouble by stoppages than the combined. Although this is true, yet it is not serious as far as short stoppages of the regular water supply are concerned, as the trouble arising therefrom would be mainly in the house pipes, which would not materially differ in both systems. Where the water supply is scant and uncertain both systems are alike objectionable.

It is a matter of fact that, although great care has been taken to prevent large matters from entering pipes and forming a nucleus for a serious obstruction, an abundance of instances have occurred where such matters have been taken out. A theoretical supposition that they cannot enter must give way to the practical fact that they do enter, if within the bounds of possibility. This objection can be made unimportant by the adoption of the Rawlinson principle of having straight sewers, both as to line and grade, between every two adjoining points of access. By this means obstructions can be more easily located, their nature ascertained, and a removal effected.

To build straight lines is not necessarily costly, and man-holes and lamp-holes can as well be put at bends as between them. The assertion that changes of direction, especially in small pipes, must be by gradual curves and not by angles is misleading and partially incorrect. The resistances of curves can be fully compensated by an additional fall. If at a man-hole the necessary extra slope can be obtained, curves of a few feet radius in order to avoid eddies are sufficient. The entire curve is thus in the man-hole, which will enable the rest of the line to be perfectly straight and capable of being looked through.

That man-holes generally fail of this use, and that a thorough inspection of very small pipes in this way is not possible, which has been said by opponents of the separate system, can be answered by making a very perfect alignment and the man-holes large enough to permit of a crouching position of the attendant. I have heard it stated sufficiently often by workmen as well as engineers in England and in Germany, that there was no practical trouble in ascertaining the nature of an obstruction in this way, and also in removing it, both of which could not be done as rapidly nor as well without the man-holes and straight lines.

It is a question, however, whether the expense of man-holes for this purpose is always justified, when they do not also serve as ventilators. The occurrence of obstructions which cannot be removed by ordinary flushing is comparatively rare in well-managed systems, and it may be more economical to break into the street on such occasions. The latter may not be objectionable in small towns; but in well-paved streets and closely-populated districts with considerable traffic the annoyance and the expense of tearing up and repairing the street may be equivalent to the cost of a man-hole or lamp-hole each time, not to speak of the difficulty in properly repairing pipe-sewers. Even though the maintenance in large cities is usually more perfect than in small ones, the value of man-holes does not seem to be less.

A duplicate system of sewers further brings with it the objection already mentioned, that wrong connections can easily be made. This trouble has often occurred in England, and would be still greater here. The disadvantages finally of separate rain-water channels have also been alluded to.

The special features which affect the *cost* of the ordinary separate system in distinction to the rest, are, after what has been said on its general features, reduced to the question of how much rain-water, if any, shall be admitted into the sewage-pipes.

Entire separation has been designed, for instance, in Oxford for detached houses, churches, for the numerous colleges, and other public buildings. Although it was desirable to extend it to the remaining part of the town, yet there was a practical obstacle in the fact that most of the continuous rows of houses were already provided with single drainage, which admitted both sewage and rain. For the rest of the town the rain falling on the back roofs and yards, amounting to about one-twentieth of the entire area, was admitted.

It is readily seen that a slight variation in the quantity of rain will have a greater effect on increasing the cost of the small pipes than of the large ones. Entire separation would, therefore, be preferable to a partial mixture in small pipes, unless the flushing effect of this small quantity of rain-water is desirable.

To lead the rain-water of the entire block into the sewage-pipes would be an approach to the combined system, as its area averages in round numbers about two-thirds of the whole, the streets occupying the remaining third.

The expense of flushing and cleaning the sewage-pipes will be about the same as in the combined system, if the latter is well attended to. In the former the flushing will have to be very regular, as no reliance can be had on the cleansing effect of storm-water. The closer attention, the more difficult removal of deposits, and the absence of rain-water cleansing in the one, is balanced by the removal of heavier deposits and a more powerful flushing necessary in the other.

The advantages of the *Shone system*, which are peculiar to it and distinguish it from the other separate systems, rest in the circumstance that the grade, and therefore the velocity of the sewage, can be conveniently increased to any desirable extent independently of the general grade of the surface. Where the velocity of the sewage would naturally be very slow, and the deposits therefore large, it may be well suited, because in increasing the grade it prevents the effects of decomposition resulting both from greater deposits and from the greater age of the sewage itself.

Objections to the system on account of the intermittent flow in the pipes, which allows particles to "strand" after the flush has ceased, might be serious if the intervals were very long. From the small size of the ejectors this will hardly ever be the case, and in comparison with the results of flushing in other systems the objection is not important.

As the cost is greatly affected by the depth of the sewers, especially in different excavations, it can be considerably lightened by this method. Yet the greater expense due to the ejectors, to the tubes distributing the compressed air, and to the principle of pumping with air transmitted to a distance, as against the direct and immediate application of power, may quite balance it, which, however, only a local inquiry can determine. The cost of maintenance is still more difficult to predetermine without a full knowledge of the locality. The greater complexity and nature of the works for pumping will probably increase it. But even considering this increase, other advantages gained may still compensate for it.

Concerning the *Liernur system* it is possible to state more definite conclusions, as a greater experience and knowledge has been gained regarding it.

The advantages claimed for this system over all others are based more on sanitary grounds than on the cost. The impossibility of any gases or germs escaping into the street, which cannot be avoided in other sewers from changes of water-level and temperature, gives it a great advantage, unless the latter are so well designed and maintained as to make such an escape practically insignificant and, in comparison with other sources of impure air, also unimportant.

Another advantage given is the fact that the sewage cannot possi-

bly penetrate the soil. The same can, however, be obtained by a careful construction of ordinary sewers, as these can be readily made water-tight under competent supervision.

The system has been extensively tried only in Holland, in flat and low sections which are intersected by water channels. It is peculiarly applicable under those conditions because it works independently of grade. At present the system is being extended in Amsterdam in the way of centralizing several scattered districts. Its actual introduction has altogether been confined to very small areas.

The objectionable features which can be placed against the claimed advantages are as follows: As the use of water in the closets is limited and by a heavy tax made impossible for the poorer classes, the system does not permit of the same cleanliness as regular water-closets, although I found that with care they were not offensive.

Kitchen, house, and factory waste water, together with the street-wash from rain storms, is to be led off by other sewers, which, therefore, alone could differ very little in design and cost from the ordinary combined system, instead of being like simple rain-water channels in the ordinary separate system. Liernur holds that owners of factories should be compelled to purify their own waste water if it becomes obnoxious in the sewers, but this demand is evidently not practicable, and sewers are precisely intended to avoid any such necessity. The inlet and catch basins he proposes, as well as his rain-water injectors, would be equally applicable to the ordinary system. They are, however, more theoretical speculations than practicable, and have nowhere been adopted. This entire branch of the Liernur system has never yet been carried out.

The cost of construction and maintenance as usually given, therefore, refers only to the removal of a small portion of the matter usually carried away by sewers, and it must be so compared. The 5-inch iron pipes, one on each side of every street, and the delivery pipes, as well as the reservoirs and the central station, are expensive to construct and cannot be as durable either as vitrified pipes or masonry.

The maintenance of the system will also cost more than that of any other, if only for the reason that the motion of the liquid, which is as fluid as any common sewage, is produced by artificial power instead of by gravity, even where this is possible on a down grade. On the other hand, it can be said that the contents of the Liernur pipes are more valuable for fertilization than ordinary sewage, because there is less dilution and admixture with valueless ingredients. As this advantage was intended to make up for the loss by an increased expenditure, it has been carefully upheld, but the dilution of the sewage has now become so great that the original idea of drying it into poudrette, and thus realizing a considerable return, is entirely out of the question. The sale of the sewage does not always pay for its transportation from the pumps.

On the whole it is evident that the advantages of Liernur's system over others will be confined to very peculiar local conditions. Where in addition to the system of iron pipes there must also be one, practically equivalent to the combined system itself, all advantages are obscured by the greatly increased cost.

Conclusions.—From the foregoing remarks, and mainly from the advantages and disadvantages claimed by the advocates and opponents of the various systems as they were stated to me, and to which I have given such relative importance and criticism, as my own inspection and examination of the works has warranted, several conclusions can now be drawn.

The sanitary demands upon a system of sewerage, it is agreed, consist in the prevention of decomposition to the greatest possible extent, and where the latter is unavoidable, to decrease its injurious effects to a minimum. This object can be best obtained by a rapid, steady, and complete removal of all decomposable matter entering the works in a fluid or suspended state, such as either causes or is coexistent with the development of germs; and also by the removal of bulky solids which occasionally enter them and obstruct the flow, and a provision for the safe escape of vitiated air.

It can be concluded, from what has been said, that these demands are fulfilled within satisfactory limits by each one of the mentioned systems, provided they are designed and built in as perfect a manner as possible, according to the principles known to facilitate such removal and to prevent any evil effects which may arise from unpreventable imperfections. A superiority of one system over another in this respect will then not depend on its specific principle as much as on the conditions of the locality where it is applied and on the care given to its maintenance. A misapplication on one hand and neglect on the other will have a much greater influence on the sanitary condition of each single system than the difference between any two systems can have under equally good conditions.

The factor, therefore, which will mainly govern a preference is less the sanitary value, as frequently asserted, than the cost of construction and maintenance. But as also the cost depends on the locality, on its physical features, on social requirements, and on the value of ground and materials, it is evident that the criterion for judging the relative advantages of the different systems, both from a sanitary and financial point of view, is the locality itself. And as the conditions presented by the various cities and places are exceedingly different, not one particular system will be the best for all localities, but different external conditions will demand as radically different solutions, both in general and detail.

This is, in my opinion, the direction in which an ultimate agreement to the various controversies, as mentioned at the outset, may be found. And as most of the objectionable features, which have caused adverse criticism, were due to faulty construction or neglect of maintenance, rather than to an essential error in the system, attention to these two subjects is at present of most importance, and will also contribute toward a greater unanimity of opinion.

It now remains to recapitulate the principal local conditions under which each of the water-carriage systems seemed to be best applicable, as far as it is possible to judge from a general point of view. In some cases it may require the closest local examination, however, to determine a preference.

The *combined system* is suitable—

Where rain-water must be carried off under ground from extensive districts, especially when they are closely built up, as in large cities, and where new sewers must be built for this purpose.

Where purification is not required or is not difficult and storm-water overflows are not objectionable in polluting the streams.

Where a sufficient amount of water or sewage is available for flushing the larger sewers.

The best examples were found in Frankfort, London, Hamburg, Brighton, Liverpool, Berlin, and other towns.

The *separate system* is suitable—

Where rain-water does not require extensive underground removal, and can be concentrated in a few channels slightly below the surface, or where it can safely be made to flow off entirely on the surface. Such conditions are found in rural districts where the population is scattered, on small or at least short drainage areas, and on steep slopes or side-hills.

Where an existing system of old sewers, which cannot be made available for the proper conveyance of sewage, can yet be used for storm-water removal.

Where purification is expensive, and where the river or creek is so small that even diluted sewage from storm-water overflows would become objectionable, especially when the water is to be used for domestic purposes at no great distance below the town.

Where pumping of the sewage is found too expensive to admit of the increased quantity from intercepting sewers during rains, which can occur in very low and flat districts.

Where it is necessary to build a system of sewers for house drainage with the least cost and delay, and the underground rain-water removal, if at all necessary, can be postponed.

Under such conditions the ordinary separate system can generally be applicable, yet certain special features of the locality may determine in favor of Shone's system; for instance:

Where pumping of the sewage to moderate elevations is advantageous or required at several or numerous points not greatly distant from each other, in order to increase the grade and velocity between them.

Where deep excavation is very expensive, either from being under the level of subsoil water or in rock, and where shallower sewers with better grades and intermediate lifts could be substituted, as in undulating grounds with rock near the surface when the sewage is to be carried across the ridges, or in low-lying and very flat districts with excavations under water.

Finally, in mentioning the applicability of Liernur's system, it must be added that it is extremely doubtful whether it can compete with the other systems in any locality. The most favorable conditions are:

Where the district is flat and low-lying, where a sufficient gradient cannot be had for a gravity flow, and where ordinary sewers are for some reason or other not expedient.

Good examples of the ordinary separate system are found at Oxford, Reading, Tottenham, and other small English towns. The best works on the Liernur plan are at Amsterdam. The Shone system has not yet been applied, except at Wrexham for trial purposes.

In conclusion it may be said that as quite different conditions may occur in the same town, it is possible and practicable to adopt several systems for it. It may be found expedient to exclude rain-water from certain areas, whereas the combined system would be advisable in others.

III. DESIGNS AND CONSTRUCTION OF SEWERAGE WORKS.

One of the principal causes of the imperfections in sewerage works which have given rise to so much controversy, can be traced, as we have seen, to improper designs or construction. It will, therefore, now be in place to indicate some of the general principles governing them which an inspection has shown to be essential.

A reason for such improper designs may be found, perhaps, in the circumstance that engineers did not fully consider the sanitary elements in the case. Sewerage works were frequently built like any other work, simply with reference to stability, and to satisfy the main laws of hydraulics.

The unfortunate fact that sewers are hidden from general observation, so that their action and state cannot readily be noticed without an effort, and often not an agreeable one, has also contributed to delay the general recognition of any other demands upon a system than purely engineering ones.

A special branch of engineering, devoted to sanitary works, has therefore lately developed, and we find that the best works in Europe have been built by specialists, such as Lindley, Mansergh, Latham, and others.

None but the combined and ordinary separate water-carriage systems will in the following be considered, as they are of the most importance.

1. *Alignment.*

The proper alignment of sewerage works, besides being governed by the topography, may also be governed by the manner in which the sewage is to be disposed of.

Three cases can be distinguished; *a*, the sewage is to be discharged into a large river near its mouth, into an estuary, or into the ocean; *b*, the sewage is to undergo eventual purification or disposal below the town, within a time which would influence present construction, and, *c*, the sewage is to be immediately disposed of at a certain point outside of the town. It is evident that these conditions may greatly modify the design.

If the city lies on the banks of a large body of rapidly changing water, as do Liverpool and Hamburg, the sewage may, if not proportionally too great, be led into it at any point, without serious sanitary objections. Should deposits of filth occur, it will generally be cheaper to dredge them occasionally than to build an intercepting sewer along the banks. The alignment of the sewers can in this case be adjusted independently of any other considerations than those of the natural drainage area to which they belong. (Fig. 1, Plate VIII.)

When, however, there is a prospect of serious pollution at a future time, several other considerations become necessary. As an interception of the sewage will then be the cheapest solution of the problem, the design should be made with this end in view, by giving the various points of future interception suitable positions and elevations in advance. Sewers too often have a wasteful descent into the low grounds, which brings the intercepting sewers below the subsoil water, adds to the height of pumping, and by a decreased grade necessitates a larger diameter, all of which greatly increases the expense.

When, finally, the sewage of a town must at once be prevented from getting into the water-course, the design will be affected still more essentially. The alignment depends, of course, on local conditions, yet there are several general features which it may be well to consider.

As the quantity of rain-water greatly exceeds that of the sewage, and, therefore, mainly influences size and cost, we must remove it by the shortest length of sewer, unless it can flow off on the surface. The sewage, on the other hand, is to have a different point of destination, either near the river, below the town, or in quite an opposite direction; or, it may require to be pumped, entirely or partly. Therefore, it is necessary either to keep them separated from the start, or to separate them at certain points.

In the first case the alignment of the sewers proper will be governed by the topography and place of disposal; the rain-water sewers, if there are any, will follow the natural slopes and valleys.

The second case admits of several variations; often a single intercepting sewer, for sewage alone, built along the shore, will answer the purpose. Examples of this are found in Paris, London, and many other cities. Two features, however, may sometimes make this objectionable. The upper end (at *a*, Fig. 2, Pl. VIII), being usually rather low to begin with, brings great lengths beneath the surface of the river and subsoil water, which greatly adds to the expense.

When the area is very extensive, or the ground slopes unevenly, it is preferable to intercept the sewage along several lines, as in Fig 3, London, Paris, and Frankfort being examples.

One of them should run near the contour, from above which sewage can flowto the out fall by gravity, as *g g*; the one below collects whatever requires pumping, as *p p*. The territory above the gravity sewer may sometimes be advantageously divided into zones, from each of which the sewage can be separately intercepted, as stated before. This will prevent the sewage from becoming too much diluted during heavy storms, before it is intercepted, and bring it more quickly to the outfall. It may also, in uneven territory, prevent sudden accumulations of storm-water in the valleys.

A third type (Fig. 4) is the so-called "radial" system, as designed in Berlin. It consists of several independent districts, the sewage from each being collected at a single point, *a*, from which the rain-water is led by an overflow into the river, and the sewage proper is raised by pumps into a collecting sewer, *p*, under pressure, which carries it away from the river to the sewage farm. This system is applicable where the ground is so flat and low that the net-work of sewers, in order to gain grade, must form several artificial basins, from the lowest points of which the sewage can be pumped into a common collector.

Finally, a combination of these principles of alignment is often possible and advisable in the same town. In Paris an intercepting sewer in the northeastern district takes the sewage and rain-water from the foot of the higher grounds to St. Denis, thus preventing an undue accumulation of water in the more level parts of the city. Besides this one, several lines of intercepting sewers on each side of the river act partly as collectors.

In Liverpool some of the main sewers act as interceptors at the foot of slopes, and further on in their course as valley line sewers.

After these more special considerations, due to the manner in which the sewage is to be disposed of, we will now allude to a few more general points applicable to all sytems.

Pipe sewers which are too small to be entered are best aligned according to the "Rawlinson principle," so that they can be completely under control. To effect this the lines must be perfectly straight between two points of access, and must have a man or lamp-hole at every bend or change of gradient, the latter taking place entirely within the man-hole. With this precaution carefully carried out in many towns, much trouble from stoppage has been avoided. The principle has been carefully considered in most English towns, also in Berlin and Danzig.

When sewers are sufficiently large to be entered, it is not necessary to have access from above to every point of deviation from a straight line. Instead of short curves in the man-holes, with corresponding loss of head, it is then better to have long and easy curves.

Further, the sewers should take the shortest way to a point of discharge. For instance, if *a* and *b* in Fig. 5 are two such points, it is more expedient to build two sewers, *c a* and *c b*, than one from *d* to *a*. The single sewer would not only have less grade, or else require deeper cutting at its lower end, but it would require a section from *c* to *a* much larger than in the other case.

Another point of importance may be gained by considering that a sewer of x times the capacity of another will not cost x times the money. It will, therefore, be economical to lead as many sewers together into mains as possible. In figures 6 and 7 this feature is illustrated, the point Q indicating either the outfall or a junction with a larger main. The length of the sewers is the same for each case, but Fig. 6 will be a cheaper alignment than Fig. 7. Concomitant advantages are found in the circumstance that the smaller sewers or branches have better gradients. Starting with the same elevation at Q in each case, the points *a* and *b* of the mains will be lower in Fig. 6, because the greater the bulk of water the less fall is necessary to produce a certain velocity, and therefore a better gradient can be obtained for the branches.

Still another principle may be mentioned. In case of sudden heavy showers on a greatly inclined surface which changes to a level below, the sewers on the latter will become unduly charged, because a greater percentage flows off from a steeper slope in a certain time. To avoid this uneven reception, the alignment should as much as possible be so arranged as to prevent heavy grades on the sloping ground at the expense of light ones on the levels. In other words, the velocity should be equalized as much as possible in the two districts. This will retain the water on the slopes and increase its discharge from the flat grounds, thus corresponding more to the conditions implied by the ordinary way of calculating the capacity of sewers. It will therefore become necessary not to select the shortest line to the low ground, but, like a railroad descending a hill, a longer distance, to be governed by the gradient. This does not necessarily imply a greater length of sewers for the town, because more than one sewer for every street is not required by it. Equalization of velocity has, moreover, the advantage that deposits are less likely to occur—a fact which should likewise be kept in view.

Mr. Lindley, of Frankfort, has adopted a general principle of alignment, which must be mentioned here. He consistently avoids "dead ends," and so does away with many troublesome points. Instead of allowing the branches to terminate abruptly, he bends each one upwards, as it were, and unites it with the sewer immediately above it, about as shown in principle by Fig. 8.* By this means the numerous dead ends are reduced to a minimum, and it is possible to flush a branch with sewage from the main above it. A disadvantage accompanying this system is a loss of grade to the former, but the possibility of a very powerful flushing at any moment will mostly outweigh it. At the few highest points of the system, as at *a*, water for flushing is obtained from subsoil drainage or the town water-supply. Penstocks, gates, or flaps at the head of each branch add expense; yet it may often be less than that resulting from the use of other methods of overcoming the troubles arising from "dead ends," such as flushing shafts or tanks; or it may be balanced by the greater advantages obtained.

2. *Size, shape, gradients, and construction.*

a. Size.—The question of size is one of great importance, not only because it materially affects the cost of the sewer, but also its efficiency. When a sewer is smaller than a certain limit, it is liable either not to carry off the sewage at all, or to become obstructed by bulky matter, and when it is too large it offers a greater surface for the adhesion, growth, or deposit of objectionable matter. Experience has caused engineers to be careful in both directions. The smallest sizes for common sewers now used in Europe are eight or nine inches in diameter, smaller ones having been found unsatisfactory and are generally abandoned. (Mansergh.) Up to diameters of 18 or 20 inches, sewers of vitrified pipe are used; beyond this there is a sudden increase to a size large enough to be entered, and then the increase is regulated according to one of the various formulæ in use and according to various allowances for rainfall.

When sewage alone is to be conveyed, its quantity determines the size. It is customary for this purpose to assume the amount of the sewage to equal that of the water-supply to the town, and in practice, when the sewers do not drain subsoil water, this is found to be nearly true. It has further been determined that one-half of the daily quan-

*See also detailed plan of Frankfort, Pl. VII.

tity is discharged from six to nine hours in different places. This consideration, according to local customs and the distance from the center of the town, furnishes the amount to be expected in a sewer per second, and for safety it has been assumed that it should fill the sewer only one-half, as in Reading and other places, where the separate system is in use.

When rain-water is to be conveyed in addition to the sewage, we find a great variety of customs regarding the amount deemed proper to provide for, which results from our comparative ignorance of the value of some of the factors coming into play. These factors are as follows:

1. The greatest intensity of a rainfall and its duration, or, in other words, the greatest amount of rain falling in a short space of time and the length of time a heavy fall continues. (See Appendix No. 2.) The ordinary records give the rainfall between the hours of the daily observations. Sometimes phenominal showers are recorded, as having lasted so many minutes or hours, during a large part of which time they may have been light and during the remainder exceedingly heavy. In rare instances only have self-registering rain-gauges been used that have indicated, for instance by a curve, the intensity of the entire shower each moment, or, at most, every few minutes; and this information is precisely what is of importance for sewerage works, which are to provide for the uninterrupted removal of all of the water. In only two towns, Zurich and Munich, did I observe rain-gauges of this nature, and these had only recently been placed.

2. The relation of the quantity of water falling to the quantity reaching the sewers. On this point, also, the observations are few and not yet satisfactory, because of the several conditions to be considered. These are: *a*, the amount of water soaking into the ground depending on the porosity of the surface; *b*, the amount evaporating from the surface depending on the temperature of the ground and air and on the duration of the storm; *c*, the physical character of the surface, whether it be comparatively smooth, like roofs and pavements, or rough, like gardens, meadows, and farm-lands, or, finally, whether it be very retentive, as in wooded country or forests; and *d*, the slope of the territory, which causes more or less rapid accumulation of the water at the low points.

Observations covering all these conditions have not yet been made; at least, not collected and made available for general use.

Some time ago* I suggested a formula, which was intended as a guide in this matter, showing in what directions the observations are most needed and in what way they will affect the ultimate discharge of water from a rain-storm. Sufficient observations, however, have not yet been obtained to determine the value of the coefficients. While in Europe I received a formula from a Swiss engineer, Mr. Bürkli-Ziegler,† aiming at a similar object and having no unknown coefficients. Regarding it as the best available one at this day for approximating the amount of rain-water likely to reach a sewer, I will give it here.

Metric measure.	English measure.‡
$Q = c\, r \sqrt[4]{\frac{S}{A}}$	$Q_1 = c_1\, r_1 \sqrt[4]{\frac{S}{A_1}}$

Where Q (Q_1) = Water reaching sewers in liters per hectare and second (cubic feet per acre per second).

c (c_1) = Coefficient ranging from 0.25 to .60 (.31 to .75) and depending on the nature of the surface, the higher coefficient being for paved streets and roofs, the lower one for rural sections of suburbs. Average recommended is .50 (.62).

r (r_1) = Average intensity of rain during the period of the heaviest fall, in liters per hectare per second (cubic feet per acre per second). The amounts ascertained for Central Europe were found to be at the rate of from $1\frac{3}{4}$ to $2\frac{3}{4}$ per hour.

S = General grade of area per thousand.

A (A_1) = Area drained in hectares (acres).

The tendency of this formula is to give amounts which increase as the rain becomes heavier, as the slope increases, and as the surface becomes less penetrable by the water. On the other hand, it decreases as the area becomes larger.

The only formula which has been used heretofore, and which has a similar tendency, is the one known as "Hawksley's."§

The formulæ‖ used for obtaining the velocity of water flowing in sewers are Eytelwein's in London, Berlin, Hamburg, and Liverpool, Prony's in Paris, Darcy & Bazin's in Vienna, Lindley's in Frankfort. When properly applied within the range of experience from which they were compiled, all give very similar results.

b. Shape.—The shape given to sewers is not governed by a uniform practice. Generally the egg-shape is adopted for all sewers of the combined system, when they are large enough to be entered; when smaller, the circular shape is preferred.

In Paris, owing to the method of cleaning by flushing trucks, a composite section is necessary. The sewage itself flows in a channel (cunette) which it fills from several inches to several feet, and the edges of which are provided with rails for the trucks. At one or both sides of it are foot-paths for the workmen, and the whole is covered by a semicircular arch. Water-pipes and telegraph wires are usually suspended in them, to be accessible at all times. Branch sewers in Paris are oval.

A great difference is noticeable in the section given to egg-shaped sewers. Some, as in Paris, Vienna, and Hamburg, have a comparatively flat invert, others, more pointed ones, as in England, in Frankfort, and Berlin. The latter appeared far more preferable and were found to need less cleaning and flushing than those with flat inverts.

It is customary in some cities, as in Liverpool, to make all sewers in public highways large enough to be entered and passed through, confining pipe-sewers to private and so-called back drainage, where the sewage is collected in a pipe running along the back of a row of houses, and discharged into a brick sewer on the main street. The advantage claimed is a more ready control of the works. In Frankfort, where many of the sewers were built by tunneling on account of the narrow streets, it was also preferred to build brick sewers 3 feet high, where otherwise a pipe sewer would have sufficed.

c. Gradients.—Generally, the grades are adapted immediately to the surface of the ground, and, as a rule, they are made as great as practicable, not only to reduce the size and cost, but to remove the sewage as quickly as possible.

In Berlin it was held that the velocity should not be so great as to reduce the section of the stream below what was necessary to give a constant flow, and therefore to decrease the tendency to deposit. In England it is recommended not to cause the velocity to be greater than six feet per second, in order to prevent a wearing away of the invert and to leave ponderous solids high and dry.*

The minimum grades are made to depend on the size and object of the sewer. House-connection pipes were seldom given a grade less than 1 : 50; valley-line sewers rarely had grades less than 1 : 1,000, and intercepting sewers were given grades down to 1 in 4,183, as in Paris. In Hamburg, and Westham near London, some were even built on a perfect level, so that the water could be made to discharge in either direction as desired with reference to flood-heights.

For sewers of the combined system it is necessary to consider two conditions: First. To properly convey and discharge the ordinary flow of sewage, the grades of the sewer should be sufficient to prevent deposit of silt but not so great as to injure the sewer. Secondly. To properly convey and discharge storm-water, it is necessary to consider the hydraulic gradient instead of the grade of the bottom of the sewer, except where they naturally are parallel. For the conveyance of storm-water, therefore, the highest points to which the water can be allowed to rise, without flooding or damaging property, should be ascertained. The line thus given is a guide for the grade of the storm-water, which ought not to rise above it at any place. This point has occasionally been overlooked. The floods in London, April, 1878, were said to have been partially due to this cause.

The outfall of a sewer into tidal rivers makes this consideration specially important. The ordinary sewage should be discharged freely at low water. The bottom of the sewer must therefore be adjusted with reference to the latter point, in order to avoid permanent backwater and deposit. The storm-water should be discharged freely at times of high water, and its velocity must therefore be calculated from the hydraulic gradient at high water, in order to maintain its full capacity at all times. (See Fig. 9, Pl. VIII.)

As the velocity, when the grades are equal, increases with the section and decreases with the length of the wetted perimeter, or, in other words, increases with the hydraulic depth of water, it follows that smaller sewers, to give the same velocity as larger ones, must be given more gradient. Towards the periphery of the areas, the grades are therefore steeper, and the profile of one sewer, increasing gradually in size towards the lower end, will, if properly designed, show in general a vertical curve, being concave towards the top.

Finally, the fact that a well-built sewer with good alignment may occasionally give a greater velocity with the same grade than a river, has been made good use of in Frankfort. By discharging into the river some distance below the town, it was possible, by giving the sewer less grade than that of the river, to drain houses in the lowest sections of the city, which otherwise would be constantly affected by the flood-waters.

d. Construction.—One of the essential reasons why the European sewerage works, wherever a pretense is made of having a system, are better than most of our own, can be found in the greater care which is generally given to their construction. The materials are more carefully selected, and, as a rule, the works are more substantial and have a better finish given to them.

In nearly all cities it has been a main endeavor to make sewers water-tight, not only to prevent sewage from soaking into the surrounding soil, but to prevent subsoil-water from draining into the sewers. In Berlin and Oxford this effort appeared to have been most successful. In both of these cities all sewage must be pumped to a considerable elevation for purification on farms, and in both the sewers were to a great measure below the level of a freely running subsoil-water,

* Proceedings Eng. Club, Phila., volume I, page 207, &c.

† Bürkli-Ziegler. Abflussmengen Städtischer Abzugscanäle. Zürich. 1881.

‡ Parenthesis and sub 1 indicate English measure.

§ See Appendix. No. 1. London. C. II. 1.

‖ See Appendix. No. 1. C. II. 1, under the various cities.

* Rawlinson: Suggestions to Local Government Board. Also Pilbrow: Separate System in Tottenham, page 10.

therefore making water-tight sewers a matter of great economy. In Frankfort the subsoil-water was also abundant, but as the sewage flows away by gravity the sewers were in places allowed to act as drains. This feature would never be objectionable if the sewage could always discharge into the river. At present the latter is causing trouble; restrictions are placed by the government upon the further admission of sewage, and purification, on account of the subsoil-water admitted, will become more expensive than otherwise. For draining away the latter as it accumulates in the sewer trenches drain-pipes have sometimes been laid below the sewer, as in Oxford and Berlin; and above or to each side of the sewer, as in Vienna and Breslau.

An important feature, as already indicated, is the degree of roughness of the perimeter of a sewer. It affects the amount of adhesion of floating particles, forming the "siel haut," and also the velocity of the water. In both cases it is of advantage to give the interior as smooth a surface as practicable.

Pipes, except near the dwellings, where grease adheres to the sides, show but a slight coating of adhering matter as compared with sewers of brick or stone. Concrete, when smoothly plastered, likewise shows but a slight coating, if any. The odor from concrete sewers, other things being equal, is said to be less than from brick sewers, and it appeared so from my inspection.

In Vienna one of the reservoirs for storing the drinking-water was partly plastered with a smooth lining of cement and partly was faced with sandstone. The clean condition of the former compared with the slimy, greenish surface of the latter, although built the same time, seems to confirm this opinion.

The materials which seemed to be best adapted for sewers and which were generally preferred, where the cost was not too great, are vitrified pipes for sizes less than 18 inches diameter, and concrete for larger sizes. The next best material is brick-work carefully laid and jointed. Iron was preferred for the main house-pipes quite generally, and was compulsory for the entire system when built according to the Liernur plan. Rubble or other stone is not used now, except in Paris, where it is, however, plastered to a smooth surface with strong cement.

Wherever a difference was made, the *hardest* materials were built into the invert to prevent scouring, as the "blue bricks," in England.

3. *Junctions.*

Under this head it will be in place to examine into a few other points, which have given more or less trouble in retarding the flow of sewage. This imperfection has been caused by an improper direction of the joining streams, by backwater, and by eddies in depositing silt or in checking the discharge, so that the full capacity of the sewer is not available.

The proper direction of the joining streams has a material influence on the velocity of the combined stream. The junction-angle should therefore be arranged so that the direction of flow of the two streams before joining is as nearly as practicable the same. Neither will then lose much velocity in endeavoring to overcome the change of direction. The less the sizes of the respective streams differ from each other the more essential is this consideration.

The junctions of larger sewers are best made with as long a radius as possible; and this feature we find pretty well considered in England and in the German cities of Hamburg and Frankfort. In Berlin some of the main junctions of large sewers are at right angles, or nearly so. Considerable deposit was noticed there, and probably other serious consequences have not been found only for the reason that the velocity in the sewers before joining is not great.

When small sewers or house-pipes unite with large sewers it is almost the universal practice to give the former an angle of 30° to 45°. It has been asserted that such junctions at times of rain can even accelerate the flow of water in the sewer. Although this is theoretically true, the effect is slight at best, and no practical confirmation of any value has been observed.

To reduce the size of a sewer by anticipating this increase of velocity is not advisable, and it is considered a very satisfactory condition if junctions do not cause an actual retardation of the flow.

When two or more pipe-sewers join, the entire curves, as previously mentioned, are made in the man-holes, so that the entire length of the sewers can be sighted. The smallness of the stream in pipe-sewers does not make this short turn objectionable. The loss of head in turning is compensated by an increased fall in the man-hole.

An important feature of junctions is, further, the relative height of the joining streams. Unless this point is considered, backwater and deposits may occur in one of the branches. Theoretically, then, the joining sewers should be so shaped as to constantly deliver the sewage of each at the same level. To comply with this demand for all conditions is impossible. It will suffice, however, to consider the ordinary flow which exists during 90 per cent. of the time. The surface of the latter in the branches should, therefore, be either the same for all, or increase in height as the bulk of the sewage becomes less. In other words, the smaller sewers should join larger ones so that their ordinary flows meet at the same level, or so that the smaller sewer discharges at a higher level. The junction of three sewers in Frankfort (Plate VII) illustrates this point.

When two streams discharge into a man-hole opposite each other, at points above its bottom, they should be placed at different heights, or else receive a slight lateral turn so that the full discharges do not directly meet each other.

The third consideration of importance in junctions is the prevention of eddies, which also tend to cause deposits, besides retarding the flow.

Eddies are produced by sudden changes in the cross-section of a certain body of flowing water. Such sudden changes must therefore be avoided and the cross-sections of two joining streams be merged into each other gradually. The so-called "tongues" are the means by which this is effected. Instead of letting several sewers discharge into a flat-bottomed chamber, the inverts should strictly be extended until the respective surfaces meet. This condition is practically approached as near as possible, and the "tongues" terminating in a point are thus formed. (See Plate VII, junction in Frankfort.) Eddies, and therefore deposits, are entirely avoided in this way, which an inspection fully confirmed. While I noticed no deposits in the junctions provided with tongues in England, Frankfort, and Hamburg, considerable silt was noticed in some junctions in Berlin and Paris which were formed by rectangular and flat-bottomed chambers.

Even in a man-hole, where several sewers join, the tongues are just as effectual in preventing deposit. The inverts are carried around by curves until the surfaces intersect, the entire bottom being usually formed of concrete, and smoothly finished. These man-hole junctions are now generally preferred to the former custom of letting the pipes terminate flush with the wall of the man-hole, thus forming a basin for deposit, as customary in Danzig and Berlin and in the older works in England.

4. *Appendages.*

In order to secure a proper reception of street-water and a ready means of inspecting sewers, certain appendages to them are necessary. Only such points shall here be considered as are essential, and which, when insufficient attention has been given to them, have caused imperfect action.

a. Street inlets, basins, or gullies.—They consist of—1, an opening or inlet to receive the street-wash; 2, a basin to retain silt, if this is deemed necessary; 3, a trap to prevent sewer air from escaping, if this is likewise deemed necessary; and, 4, a pipe connecting the structure with the sewer.

The *opening* is either horizontal, placed in the gutter and covered with a grating, or it is vertical and flush with the curbstone, or both plans are combined. A grating in the gutter can only answer when the streets are kept free from matter which could clog the openings, such as leaves, manure, &c. They are extensively used in Europe. (See Table I.)

TABLE I.—*Street inlets and gullies.*

City.	Location and distance apart.	Common position and size of opening.	Depth of basin below surface.	Trap and seal.	Diameter of discharge-pipe.	Remarks.
London	Within block, 150 to 300 feet	Grating in gutter, 16 by 18 inches.	About 4 feet	6 to 12 inches	6 to 9 inches	Some have neither trap nor basin.
Paris	Within block, varies with grade	Side opening in curb, 4 by 40 inches.	No basin	None	At least 4 feet high.	
Berlin	Within block	Grating in gutter, 16 by 20 inches.	7 feet 4 inches	Screen in place of trap.	6 to 9 inches.	
Vienna	Within block	Grating in gutter, 12½ inches to 18¾ inches square; side opening in curb 4 by 12 inches.	4 to 6 feet	Some are trapped	3 to 4 feet high.	
Liverpool	Above intersections, 200 to 300 feet.	Grating in gutter, 12 by 14 inches.	4 feet 6 inches	14 inches	9 inches.	
Hamburg	140 feet	Grating in gutter, 15 by 17 inches.	4 feet	None	9 to 12 inches	Basins are only used on macadamized streets.
Frankfort	120 to 150 feet	Grating in gutter, 13 by 18 inches.	7 feet 8 inches	6 inches	6 inches	Iron bucket is placed in basin to catch the silt.
Danzig	At intersections, 200 feet	Grating in gutter, 10 by 14 inches.	5 feet 9 inches	6 inches	6 inches.	
Brighton	150 to 300 feet	Grating in gutter, 16 by 27 inches.	2 feet 9 inches to 3 feet 6 inches for iron basins; 5 feet for concrete.	6 inches	9 inches	The large concrete basins are not trapped.
Oxford	(?)	Grating in gutter, 14 by 18 inches.	3 feet 6 inches	(?)	(?)	Have a basin and a trap.

A vertical opening on the line of the curb is therefore more expedient, as it cannot be obstructed by the ordinary street-wash. But it is only safe when the discharge-pipes as well as the sewers are large and the introduction of bulky matter which may find its way into them is not objected to.

A combination of the two methods may be considered a transitional state, being practically the same as the second and more expensive.

Where sewers are large and the grades are not too light or when there are good flushing facilities, side-openings in the curbs are preferable. For pipe-sewers, and light grades, gratings in the gutters are necessary.

The size of the openings when grates are used varies from 10 by 14 inches in Danzig to 16 by 27 inches in Brighton. (See Table I.) The side-openings are shallow, from 4 to 5 inches high, and 12 inches to 40 inches long. When located at the corners of streets, as usual in America, the inlets require a turning of the stream, and therefore cause some damming up, thus necessitating a greater section than when inlets are above the corners, as is common in Europe.

Another essential part of the gully is the *basin* for the retention of silt. Objections have been raised against it on account of the foul matter which may accumulate therein. But when every house is connected with a sewer and the streets are well paved and well cleaned, the water remaining in the basins does not become very offensive, and I nowhere found them so. When, however, much kitchen-waste runs into them, or when the streets are kept dirty, a very frequent cleaning is necessary to avoid offensiveness. Basins furthermore do not prevent the washing of fine silt into sewers during rain-storms, where it deposits as soon as the velocity diminishes.

Wherever it is at all possible to do without basins, they should be dispensed with. In Hamburg and Paris the flushing facilities are such that they could be omitted on all of the paved and well-cleaned streets.

In Frankfort the removal of silt is facilitated by placing buckets perforated near the top in the basins to retain the heavier solids, and permit of being easily taken out; in other cities scoops are used.

The depth of the basins varies with the climate. It will be noticed (See Table I) that in England they are comparatively shallow, while in Germany they are almost twice as deep on account of the severity of the frost.

Regarding the *trap*, we find it entirely omitted in Paris, Hamburg, and occasionally in London. In Leeds it was removed with good effects. In Berlin the original trap now acts simply as a screen, being perforated at the top. Wherever the sewers are properly built and well maintained the absence of a trap would seem to be rather a benefit to the system than otherwise in permitting a better circulation of air. Only where inlets are placed in narrow streets and near windows, has it been found necessary in all cases to prevent the occasional escape of foul air. As a rule, the cleaning facilities are such that a constantly perfect condition cannot be guaranteed, and the omission of traps must be treated with a great deal of caution. It could hardly be recommended for American cities. In the table it is noticed that the depth of water-seal in the mentioned cities varies from six to fourteen inches, which fully guards against evaporation.

The diameter of the *discharge-pipe* into the sewer varies from six to nine inches in those cities where the inlet is a grating in the gutter. The amount of water ever delivered to a sewer from them could be carried by a three or four inch pipe, but it is preferred never to use less than six inches. Where side-openings are placed in the curb, which permit bulky matter to enter, a larger diameter, at least 12 inches, is customary. In Paris and Vienna the connections are large enough to allow men to go into them from the sewer.

The ordinary location of sewer-inlets in Europe is not at the street corners, as in America, but slightly above them or near the middle of the block. They are also placed closer together than here, which explains their smaller capacity. This greater frequency appears to have no special advantage, but the avoidance of inlets at street intersections has several. The deep gutters at the sidewalk-crossings are obviated, which in winter are often very objectionable. It is further possible on suitable pavements and grades, to allow the rain-water to run over intersections to another block. The advantage of this is a saving of inlets and the keeping of rain-water as long as possible on the surface, which not only assists the cleaning of the pavements, but diminishes the size of the sewer below. The practicability of thus permitting rain-water to run across street intersections depends on having a smooth pavement, such as Belgian block, wood, or asphalt, with a slight and suitable camber to avoid pockets, conditions which are common in London, Liverpool, and many continental towns. It also requires the waste-water from every house to be led into the sewer, and that nothing but rain-water be allowed on the surface of the pavements. If these conditions cannot be had, inlets are necessary at every lower junction of two descending gutters.

A word may still be added with reference to the gutters themselves. They vary from ditches (two feet deep in the older parts of Berlin) to the simple depression caused by the slope of a cambered street and the curbstone, which is generally only three to five inches deep. The objectionable features of a rough and deep gutter are that it retains rather than removes street dirt; that it is unsightly and sometimes even dangerous. Its best form in a sewered street is the natural channel formed by the surface of a smooth pavement with the curb. That the gutter should be as smooth as possible, is necessary in order to allow a comparatively small amount of service or rain-water to run off readily, and therefore cleanse it.

b. Man-holes.—Accordingly as sewers are entered from the street or the sidewalks, two different structures are used. When the traffic is sufficiently great so that an obstruction in the street, caused by opening a man-hole for inspection or cleaning, is annoying, a passage-way is built from the sewer to the sidewalk, with an entrance on the latter. These are called side-entrances, and are used in the central parts of London, in Paris entirely, and in Hamburg and Frankfort in the most frequented streets. The only objection to them is their expense.

Man-holes, when placed directly over the sewer, are by far the more common of the two contrivances. The section is generally round, varying from 2 feet 6 inches to 3 feet diameter. In Vienna it is 2 feet square; in Liverpool rectangular, 2 feet 2 inches by 1 foot 6 inches, and in Brighton 2 feet 6 inches by 3 feet. The circular form seems the best and is most economical. For pipe-sewers an elliptical section is preferred, which gives room at the bottom to work in. In Liverpool a chamber is commonly built for this purpose.

For a large sewer the man-hole is built on its side-walls, the invert continuing its course without interruption. For pipe-sewers in Danzig and Berlin, the man-holes have been built with a square or rectangular bottom, letting the pipes enter above it, and forming what has been called the "pot-and-pipe system." The objection to basins thus formed is that they retain decomposing matter. The better plan, which is now pursued in England in preference, is to carry the pipe-sewer in semicircular section through the man-hole, and thereby offer no chance for deposit. As man-holes are extensively used for ventilation, they are provided with the following arrangements for that purpose:

In some cities, notably Vienna and Hamburg, they are covered with an open grating, through which the air can freely escape and the street dirt drop into the sewer. In others, the man-holes are covered by gratings, partially open and partially closed with blocks of wood, intended to deaden the sound made by vehicles passing over them. In Berlin the holes are near the periphery, the blocks in the center. A few inches below the cover, a sheet-iron plate rests on a few projections. This plate, having holes in the center, under the blocks, permits the circulation of air and at the same time prevents street dirt from dropping into the sewer. In other cities, especially in England, the holes are in the center, while the blocks are near the periphery. A bucket, box, or pan is then suspended under the center to catch the dirt, while ventilation is obtained at the periphery. Of these two plans, the latter seems to be slightly preferable, because the dirt can be more readily lifted out, and because the grating has less metal exposed to the passing wheels. The common plan in England, but one which is more expensive without offering additional advantages, is to close the man-hole with a tight cover and to build a small catch-basin, communicating with it, to one side, which then receives an open grating about 9 by 18 inches in size, the basin being about two feet deep.

A final point to be considered is the distance between man-holes. In Paris it is fixed at one hundred and sixty-four feet, a deviation being made only when a crossing or other obstruction compels it. In Vienna the distance is about two hundred feet; in Hamburg three hundred and fifty to four hundred and fifty feet; in Frankfort five hundred and forty to six hundred feet for large and two hundred and fifty to three hundred feet for small sewers.

Where pipes are used a man-hole is placed at every change of direction, usually at a street intersection, and, on long straight lines, two hundred to three hundred feet apart. The rule that the smaller the sewer the nearer should the man-holes be placed, is generally observed. Where sewers are well built and well flushed, man-holes need not be as close as when the sewers require much clearing by hand labor.

c. Overflows and outfalls.—Two more subjects require some inquiry, where imperfections can have serious results.

Overflows.—Storm-water overflows are not practicable for sewers which themselves run to the nearest natural outfall. They are therefore confined to intercepting sewers, and their advantage consists in causing a reduction of size in the latter below an overflow.

Two designs are in use. One permits the ordinary sewage to drop through an opening in the invert of a valley-line sewer into an intercepting sewer which crosses underneath it. The storm-water, which attains a greater velocity, leaps over the opening and continues its course to the river. Unless the size of this opening is carefully designed and allows of graduation, its action has been found unsatisfactory either in delivering too much water into the intercepting or too much sewage into the overflow sewer. A better contrivance, and one more commonly used, is an opening in the side of an intercepting sewer through which the water, after reaching a certain height, can flow off into some other channel. The proper height at which this is to begin must be determined from the degree of pollution permissible for the water delivered by the overflow sewer. The proper shape will be a long and shallow vertical rectangle, permitting a sheet of water to run over and to give the the desired bulk. When the intercepting sewer, which is to be relieved of the storm-water, is straight, the overflow sewer should

start with as easy a curve as possible, to prevent a check upon the velocity, which, during heavy rains, might have serious results. A better plan is to curve the intercepting sewer so that the overflow forms a straight continuation of it, while the ordinary flow makes a curve, because the storm-water would suffer less retention, having a greater velocity. The position and frequency of such overflows will depend on the pollution allowable, on the topography, and on the existing sewers which may be used for this purpose.

Outfalls.—The location of the outfall of a system of sewers will depend, not only on the topography and on the indications regarding the growth of the town, but also on the manner in which the sewage is to be disposed of. When purification is necessary, the outfall must be at the locality where this is to be carried out. Commonly such laces are below the town and near the water-course into which the effluent sewage can be discharged. In some cases, where no land is available below the town, the sewage must be carried to other points. In Berlin it is pumped to farms situated several miles from the river, the effluent discharging partially above the city. In Leamington and some other English towns the sewage farms are also not below but at one side, on some tributary streams. When purification is not required, and the sewage is discharged into a river or the sea, the location must in both cases be below the town, to prevent pollution of the shores in front of it. Along the sea-coast the prevailing currents determine which direction is below. In rivers or estuaries, where the tidal range is great, it is necessary to carry the outfalls so far down that the returning tides cannot bring back the sewage to the town. It will be necessary, besides, to store it either in reservoirs or tank-sewers during incoming tides, and to discharge it only at times which will prevent its return. If the outfalls are distant, the sewage can safely be discharged before high-water, as in London, and continue for three or four hours after it. The main features regarding the location of the outfall are herewith indicated. It remains to examine into its position.

When pumping is necessary, it is a matter of economy to design the outfall so that the elevation to which the sewage is raised can be varied with the level of the body of water into which it is discharged. For tidal rivers, only such portion of the sewage may be pumped to the elevation of high tide as must be discharged at this elevation, as, for instance, at Crossness, London.

When sewage discharges by gravity, the position of the outfall is governed by the tides as well as by the elevation of the lowest part of the country which is to be drained. In all cases a sewer should be placed at an elevation which will permit of a free discharge of the ordinary flow of sewage at low-water. (See Plate VIII, Fig. 9.) Another governing point is, that the hydraulic gradient of the storm-water flow, determined at the highest spring tides, should be the gradient by which the size is determined. If this is done it matters not how far the sewer is placed below high tide, as it will never be tide-locked.

In fact it will sometimes be advisable to sink the outfall entirely below water, carrying it in a submerged conduit on the bottom of the river or bay to a point in the current, to have a more rapid dispersion of the sewage and to prevent it from accumulating in the docks and along the shores as in Hamburg, Brighton, &c.

When the hydraulic gradient cannot be raised to high-water at the outfall without causing the flooding of cellars, or even entire districts in the city, it will be necessary to close the outlet by a penstock or tidal flap, to prevent the tide-water from entering the sewer, which then acts as a storage tank until the tide recedes. This treatment is common in London, Hamburg, Danzig, and other places. In the case of a heavy rain-storm during the time when the sewers are locked against high tides serious results are apt to follow if provision is not made for this contingency.

In Hamburg the canals running through the city are also closed against the high tides in the river, and in thus forming a basin the storm-water overflows discharge into them at such times and relieve the sewers. When a similar expedient is not possible, the only guard against this trouble is the interception of rain-water and discharge at higher elevations, or its removal on the surface by the introduction of the separate system.

5. *Ventilation.*

The question of ventilating sewers is one on which there are yet very decided and opposing views.

Many different methods have been proposed and tried, and none of them have singly satisfied all requirements. A comparison, however, will show, I think, in what direction we may find an ultimate solution.

Ventilation may be had in two ways: by means of natural forces at work in a sewer or an artificial force. The former can, in the main, be stated to be as follows:

1. *The difference of temperature of the sewer and the atmosphere.*—While the latter varies greatly, the former remains almost stationary, thereby tending at one time to cause the air to escape from the sewer, at another to be drawn into it; or sometimes to move along the sewer toward the higher parts of the system, and at other times to move downward.

2. *Change in the quantity of sewage.*—Not only the varying amounts of water used in the dwellings, &c., constantly produce a change in the bulk of sewage, and, therefore, of the air contained in the sewer, but during a rain-fall these changes become very marked.

3. *Frictional force of the flowing sewage.*—A current of water, as any other body in motion, carries a certain quantity of air with it by friction. And this is true not only for vertical but also for slightly-inclined pipes, and the amount of air drawn along is dependent on the exposed area and velocity of the sewage and not on the size of the sewer, except when it is running full or nearly so.

4. *Wind blowing over street-openings and into outfalls.*—Whenever a strong current of air passes over a shaft-opening in the street it will affect the circulation in the shaft, either by causing a downcast or an upcast, as the direction of the wind may be. A sewer outlet exposed to the wind will cause a similar effect.

The interaction of these forces produces a natural circulation of air in the sewers in any case. And it must be provided for if traps connected with the system are to maintain their object.

The artificial circulation of air is attained either by the plenum or vacuum systems, *i. e.*, by the creation of a draught in forcing air into the sewer or in drawing it out.

It will be evident that near the motive power the pressure is greatest, and that it will diminish as the distance increases. Therefore a very unequal pressure is caused throughout the sewer. And unless it is air-tight and the traps sufficiently guarded to withstand both the greatest and the least pressure, the effect of the artificial draught will decrease very rapidly.

Various appliances have been used for obtaining this artificial ventilation. The most successful example that came within my notice was in Brighton (Appendix No. 1, C. II, 4), where a large stack, 200 feet high and 6 feet in diameter, has been built to ventilate 2 miles of an intercepting sewer. A fire is kept burning constantly, and the draught is just noticeable at 2 miles from the stack, when all openings on this stretch are carefully kept closed. There are no house connections on this line. Although there may be instances, like this one, where artificial ventilation is to be preferred, it will be evident that it cannot be recommended for entire sewerage systems, but is only useful where there is no danger of destroying traps, when the natural circulation of air in the sewers can be counteracted with sufficient force, and when no more economical mode of ventilation is advisable.

The natural method of ventilation is otherwise to be preferable, and it remains to examine into it more closely.

The forces operating in a sewer, it has been said, compel the air sometimes to flow into it and at other times to flow out, and to rise to the higher portions of a sewer or to fall to the lower ones. By facilitating this free motion of the air, a natural and almost constant circulation is obtained.

The means employed to facilitate this action are shafts communicating with the open air. High shafts have been built at the upper ends of sewers, as, for instance, in Frankfort. But, although the impure air is led off effectually, the expense of such towers is hardly warranted, because cheaper means will accomplish the same object. Gas posts have sometimes been used as ventilators. In Glasgow, for instance, where it was expected that the heat would create a current, the latter idea has been given up as there are frequent downcasts, and the posts are now used simply to enable the sewer air to escape when necessary above the pavement in a way not to be annoying to pedestrians.

The rain-water pipes of houses, when connected with sewers, have also been proposed as ventilators for the latter. Yet this is objectionable, not only because they are as a rule insecurely jointed and often open out near garret windows, but because they do not act at the time when their action is most needed, namely, during a rain. The column of falling water tends to carry air down with it, instead of letting it escape, when the sewer is filling up with water and endeavoring to expel the air. When rain-water pipes are the only means of ventilating sewers, their action is even entirely cut off when the sewers fill up above the point where the house-drains enter.

The soil-pipes of houses carried above the roof are now much used for sewer ventilation and have fewer objectionable features than the rain-water pipes. When they are inside of the houses and are not well jointed, the danger of the escape of sewer air into the dwellings is apparent. But it must be said that as a rule the house-pipes will always be in a worse condition than well-kept sewers, and, therefore, if the pipes are sufficiently tight to prevent any escape of gases originating in the house-pipe itself, they will also prevent an escape of gases from the sewers.

A valid objection to soil-pipe ventilation, if it is to be the only method employed, is again the fact that if the water in the sewers rises above the house connection, all ventilation through houses is stopped. This might be obviated by leading house-water into the sewers at the soffit. But this would not only cause the sewer to be impassable, but require that it should be built to a greater depth than if the house connections enter at or near the springing line.

The advantages on the other hand are, that the circulation in the house-pipe itself is facilitated by the pulsation of the sewer air, and that the lower opening in the house drainage near the sidewalk or yard is avoided, where often disagreeable exhalations are noticed. Still another advantage lies in the circumstance, that when the venti-

lation through street-openings fails, as in winter when heavy snow or ice covers them, the action of the soil-pipes as ventilators is not impaired.

In England, ventilating sewers through soil-pipes is objected to, because an escape of sewer air into the house is feared. In Germany, it is advocated in Hamburg, Frankfort, Berlin, Danzig, and other towns. The great amount of snow and ice during the winter in German cities, obstructs the ventilation through street-openings, and other methods are compulsory. As the winters in England are very light, the necessity for other ventilation than that obtained through street-openings does not appear. This circumstance may partially explain the different customs and opinions.

Lastly, the most common and most effectual method of sewer ventilation is that of leading shafts from the sewers up to the surface of the street and covering them with an open grating.

This plan is also the cheapest, because it requires but a slight additional expense for the structures, such as man-and-lamp holes, which themselves are necessary for other purposes.

The contrivances to permit free exchange of air and to catch the street dirt dropping through the openings have already been alluded to. It is now necessary to inquire into the effects of ventilating into the street.

If the sewer air is uniformly diluted, when it escapes at the surface, its quantity at any point decreases very rapidly, *i. e.*, as the cube of the distance from the opening. As a matter of observation, I found only in rare cases any noticeable odor at the distance of a few feet from the ventilators, and then it was only the case when the sewers were declared to be in an imperfect or unclean condition. When they were moderately clean the exhalations were in no way objectionable.

As it is impossible in all cases to guard against the escape of some foul air, various devices have been proposed to purify it. Among all of them the charcoal method is the cheapest, best, and most used. The appliances consist of a basket of spiral or other form, in which the charcoal is placed so that the sewer air, in escaping, passes over it. The great absorbing power of charcoal is in this way made use of to absorb the gases. This basket is suspended near the top of man-holes, or of special shafts, or it is placed between the man-holes, which then receives a closed cover, and a side catch-basin with a grate cover, in such a manner that no air can escape without coming into contact with the charcoal. The action is good if the latter is prevented from absorbing too much moisture, and is not in use over 6 months. The expense of charcoal and its continual replacing precludes a general adoption of this method and it is now used only in places where the escaping air is very obnoxious.

In order to ventilate sewers into the street without causing a nuisance, it therefore becomes necessary to build them in a manner which will secure a good circulation of air at all times, and also to keep them clean, which latter is necessary from an independent point of view, to prevent, as much as possible, decomposition, propagation of germs and expulsion or escape of air in undesirable ways, and, finally, in order to enable them to be entered without danger. Whenever it may not be possible to secure this condition permanently, some other more costly or less efficient method of attaining ventilation must be employed, which local circumstances will determine. It may be advisable to insert charcoal ventilators at certain points, or, in short sewers, to use the outfall in connection with soil-pipes, and to omit ventilating man-holes entirely.

The *conclusions* which present themselves may now be stated as follows: The most economical and effective method of ventilation is by short shafts in the streets, placed at frequent intervals. The next best method is a free communication with the outer air through the soil-pipes of houses, under the proviso that they are properly constructed.

As the former method often becomes inoperative in the winter, and the latter requires the overcoming of considerable friction, owing to the length and comparatively small size of the pipes, which greatly retards the circulation, neither, solely, appears to answer all conditions. Both methods in conjunction, however, satisfy in general the requirements. Ordinarily the street opening would effect the exchange of air, and the soil-pipes would draw the air necessary for their own ventilation from the sewers. When the former do not act a circulation can then be secured through the latter. If it is required to guard against all contingencies, it remains yet to provide for the case, when both the man-hole covers are closed by snow or ice, and the sewers are filled from a rain or sudden thaw so that the house-drains are also inoperative. This condition can be satisfied by leading a special safety ventilating pipe from the soffit of the highest point of the sewer and from man-holes, as may be desirable, into special stacks, chimneys, gas-posts, or house soil-pipes, according to necessity or convenience.

It appears therefore, finally, that the natural method of ventilation provides for all cases; it can secure a sufficient circulation at all times; it is more economical and therefore, on the whole, preferable to the artificial method.

IV. MAINTENANCE OF SEWERAGE WORKS.

A striking contrast is observable between the average ordinary condition of the sewers in Europe and in America, and it is in this want of proper maintenance perhaps more than in any other point that our sewerage works have often failed to answer their intended purpose.

If sewage were a uniform substance, like water, gas, or air, its conveyance through channels could be as readily accomplished as the water and gas supply of a city. But the sewers contain fluids, solids, and gases of the greatest variety in bulk and weight, and sometimes in proportions which cause injurious conditions or imperil the proper action of the sewers.

Entire self-action, therefore, cannot be relied upon. Occasional inspection is unavoidable in order to prevent serious obstructions, and artificial assistance in removing deposits becomes necessary from time to time.

Several methods of cleansing sewers are in vogue.

1. *Free flushing by means of sewage or water from the town supply.*

This is the most common and cheapest way of removing deposits. The appliances for it vary with the size of the sewers, and with the customs in different cities.

At the head of a small pipe-sewer, it is difficult to collect enough sewage in a short time to flush the same, therefore city water is generally used at such places. In Liverpool the end of the pipe is bent up to the street surface, and there is fed by a hose attached to a fire plug, or, large iron flush-tanks, mounted on wheels and filled with water, are suddenly discharged into the sewer. In most cities, both in England and Germany, a flushing shaft is placed at the highest point, and is filled from the city water-pipes. On drawing a valve or stopper, the entire contents are suddenly discharged through the pipe. Man-holes on the line of the sewer are also often used as flushing shafts, as in Danzig, Berlin, London, and Oxford.

Field's self-acting flush-tanks have occasionally been inserted at the ends of sewers in England; one at Aylesbury, 12 inches diameter, has been in use for several years. They require occasional inspection, and are only satisfactory when supplied with clean water, not with sewage.

When the sewers are larger than 12 inches or 15 inches, it becomes necessary to use a greater bulk of water than can be collected in a man-hole, shaft, or tank. The sewage is then dammed until a sufficient amount accumulates, which is suddenly released. Small sewers of 12-inch to 18-inch pipe are dammed by flushing slides, which are placed in front of a pipe in a man-hole and drawn from above. In Oxford, for instance, the sewage is allowed to rise to a head of from 18 inches to 3 feet before the slide is drawn.

Brick sewers have gates and pen-stocks for the same purpose. The former are better than the latter, because they are swung from the side and open suddenly, whereas the latter, worked from above, are raised by means of a screw. Wherever a large body of water is to be mastered, pen-stocks are preferred, and the mechanism is usually arranged so that one man can operate it.

Where the grades are light and the damming of sewage in larger sewers would drive it back into smaller ones, flushing has sometimes not been favored. In Berlin, for instance, it is only used for the smaller sewers, while the larger ones are cleaned by hand.

The alignment advocated by Mr. Lindley and executed in Hamburg and Frankfort, is arranged, as already mentioned, with reference to the avoiding of dead-ends and the facility of flushing small sewers from larger ones. The sloping ground is crossed by intercepting sewers, and the branches of the districts below each one of them are connected with them, so that the water from the intercepting sewer can at any time be turned through one or more branch sewers, thus giving them a powerful flush. In Dantzic, a similar object is accomplished by leading a pipe supplied with clean water along the periphery of several large areas and connecting the highest ends of the branches with it. At any time the entire contents of this pipe can be turned into any of the smaller sewers.

River water has also been used in a similar way, where the sewers were below its level at the upper end and above it at the lower, as in parts of Danzig. Sea water has likewise been of service in this direction. At spring tides, the sea water is admitted at the upper end of the long intercepting sewer in Brighton for four or five days in succession. It is stored for two or three hours, and then allowed to sweep down to the lower end which it reaches, at the time of low tide.

As the effect of a flush is gradually lost by a decrease of velocity and an equalization of the flow, it is necessary to place the flushing gates, &c., at frequent intervals. The distance apart also depends on the gradients, as it is generally required to get the full benefit of a flush before the water is again penned back. A local consideration, therefore, must decide what distance is best. In Europe it varies greatly, ranging from 300 to 5,000 feet.

The method pursued in flushing is, generally, to begin at the highest point and work downwards. In this way the silt is gradually flushed down and out. In Hamburg, the lower parts are cleaned first, which has the advantage of preventing a great accumulation of silt toward the end of the flushing.

The frequency with which sewers are flushed likewise varies. In Berlin the period is two weeks, in Danzig and Frankfort three weeks. In Hamburg the sewers below the Alster basin are flushed twice a week; the rest are flushed every two to three months. In England,

sewers are flushed at intervals of one to three months. At the time of flushing there is usually an inspection, and a monthly or quarterly record is sometimes kept of the condition of the sewers, as in Hamburg, Frankfort, Berlin, and Vienna.

2. *Flushing by means of a movable dam.*

Under this head I shall group the method of cleaning sewers which is the common one in Paris. According to it the sewage is dammed up by an artificial and movable obstruction, which nearly fills out the invert, leaving but a narrow space around the perimeter. The available cross-section of the sewage is reduced thereby, so that the velocity is correspondingly increased. This increase loosens and scours up the silt which is slowly and automatically pushed along in front of the artificial dam, which is itself moved by the rising water in the rear. This dam consists in open sewers usually of vertical aprons or scrapers (French, vanne), which are suspended from the front either of boats, floating on the dammed-up sewage, or trucks running on rails fastened to the edge of the inverts. In submerged sewers or syphons the same effect is accomplished by a ball (French, boule) of slightly less diameter than the sewer, which in this case must be circular in section.

In both cases the propulsion is automatic, as it is caused by the water itself, and although the process is a slow one (about 2,500 feet can be gone over in a day) it effectually accomplishes its object.

In operating the scraper it is necessary to adjust its height with reference to the amount of scour required. If there is a considerable amount of silt in the bottom it is possible to remove only a top layer, as it were, and to lift the dam accordingly. A second or even third flushing is then required to remove it all. Whenever the amount of silt in front of the dam accumulates so that the motion of the latter is impaired, the silt is dredged out and loaded into a boat or a tip-wagon, as the case may be, in which it is removed to an outlet.

The syphon at the Pont de l'Alma, crossing under the river, and which is one meter in diameter, is cleaned by passing the ball about once a week. A head of water of 1 foot 8 inches to 7 feet can be obtained, which has always been sufficient to roll the ball through in a few minutes. In England this method of cleaning syphons has also been tried, but in smaller pipes and with less success. It appears that a large mass of water causes the ball to act with more certainty than a small one.

It will be evident that the cleaning of sewers by movable dams must be more expensive than by a free flush. Yet where grades are so light, as in the large collectors in Paris, the latter would have but little effect, and so the additional cost is justified, especially as it is much less than for cleaning by hand, the only alternative.

3. *Cleaning with hand tools.*

Where the foregoing methods are not available or do not remove the obstructions, a partial or an entire cleaning by hand becomes necessary. In Paris and Liverpool small trucks gauged to run on the inverts are used to convey the silt, which is shoveled into buckets placed upon them, to the man-holes, and there lifted out, or, as in Paris, to the larger sewers and there dumped into the flushing trucks. The tools used are scrapers, hoes, and shovels of suitable shape and size. The larger sewers in Berlin, which are not flushed, are cleaned with hoes, by which the silt is dragged to a large catch-basin at the outlet. This cleaning is done every two weeks, but the catch-basin is cleaned daily of the silt carried down by the ordinary flow. In Oxford, the pen-stocks are so arranged that certain sections between them can be temporarily dammed against the sewage from either end, which permits the removal by hand of serious obstructions, and also a general examination of the condition of the sewer.

In Brighton, where a good deal of sand washes into the sewers, large catch-basins are placed on the line, especially just before discharging into the intercepting sewer. These are cleaned every day or two.

In Vienna, where flushing has not yet been introduced, the contents of the house passages, which are large enough to be entered, are scraped out once a month into the public sewers. These are then cleaned at intervals varying with the grade. Sewers having a fall of less than 5 feet per 1,000 are cleaned once a month; those having a grade between 5 and 10 feet per 1,000 every two months; and all over 10 feet per 1,000 are cleaned every three months. When deposits are reported to be greater than 3 inches, a special cleaning at intermediate intervals is required.

The points where flushing does not always remove silt effectually, are the stretches after which a heavy grade has changed to a light one, and therefore checked the velocity. Also at the lower end of a flushing section, where the stream has lost its force, deposits are likely to remain. At such places, after-cleaning by hand is sometimes resorted to.

When pipe-sewers cannot be thoroughly cleaned by flushing, it is necessary to insert tools and to draw them entirely through. In England, circular brushes are used for this purpose; they are drawn by means of a rope first floated through by a flush. In Berlin, cylindrical brushes, filling the pipes, and 1 foot to 18 inches long, are used similarly. When this does not answer, one-half inch iron pipes, 6 feet long, are attached to each other with a disk at the end, and are pushed through the sewer. In Danzig, brushes and disks are also used in this way. In Berlin it is sometimes found expedient to use both the cylindrical brushes and flushing at the same time, the former loosening the silt, the latter assisting the motion and cleaning.

When neither of the foregoing methods are available, jointed hooks are sometimes inserted, which close when pushed into the pipe but open by means of a spring when pulled back, acting then as a hoe.

A word must also be said here about the cleaning of catch-pits under street inlets or gullies. In Frankfort every gully has a bucket standing in it, into which the silt drops. These are lifted out and emptied at intervals of from three days to three weeks, according to the character of the pavement and the weather—generally every two weeks. In all other cities the basins were cleaned by scoops at intervals varying as above.

4. *Management of sewerage works.*

In Appendix No. 1, under B, I have given outlines of the organizations in charge of sewerage works and of the manner in which these are conducted. It will be seen that all matters concerning their design, construction, and maintenance are generally under the supervision of one and the same department. In London, on account of the very large territory, it has been found expedient to intrust the construction of branch sewers to the "district boards" of the respective sections, each one of which has an engineer, with a corps of assistants. But all plans must be approved by the metropolitan board of works, which is charged besides with the making of all designs, with the building of all works connected with the intercepting system, and with main valley line or "Schedule D" sewers, as they are called.

In Paris the water supply and sewerage works are placed in charge of one department. The water-mains are placed in the arches of the large sewers and in still other minor points the two subjects stand in some relation to each other. Therefore, to facilitate the operations, they have remained under a single department.

In Berlin, where sewerage works are at present being extended over the entire city, a special department was established for the design and construction of the new system. Its duties will expire on completion of the works. As soon as a section is finished it is turned over to a permanent department which is charged with its maintenance and with the extensions that may from time to time become necessary.

In the remaining cities the design, construction, and maintenance are placed under one head.

The execution of the work is differently treated in different places. As a rule, all new works are built under contract, Berlin being the only prominent city where the department itself takes charge of the entire construction. The maintenance of the sewers, on the other hand, is quite generally conducted by department officers, and in rare cases is contracted for. Before the year 1871 the London sewers were cleaned and repaired under contract, but then it was decided to have them cleaned thereafter by men under the immediate direction of the board, repairing only to be done by contract as before.

In Paris all new works and repairs are under contract, but cleaning is done by department employés.

In Vienna new works, repairs, and cleaning are all contract work; the passages leading from the sewers into the houses, and into which the various house pipes discharge, even being included.

In the remaining cities, as a rule, the departments maintain the sewers with a permanent corps of men, and contract only for new works.

As to the actual condition of the sewers as found by my inspection, I have to state that among the larger cities the cleanest works, as a whole, appeared to be those of Frankfort, Hamburg, and Paris. The sewers lately built in London, Liverpool, and other English towns were also in a very good condition as far as they were examined. In Berlin the flat gradients showed considerable deposit of soft mud and fine silt, readily yielding, however, to a strong flush, except in rare cases, when the accumulation of sand and grave obstructions necessitated other means.

In Germany the cleaning is generally done at night, especially when the man-holes are in the roadway. When entered from the sides, day cleaning is not considered objectionable. In Vienna, where the silt is lifted out of the sewers and carted to the Danube canal, there to be loaded into scows and removed, the cleaning is also done at night. In Paris and England the sewers, as a rule, are cleaned during the day.

V. COST OF SEWERAGE WORKS.

The costs of various items connected with sewerage works, as far as they were ascertainable, are given in Appendix No. 1, under E, for each city. The following table is compiled and extended for those cities only where the information was sufficiently complete. To be rightly understood the figures must be compared with some allowances, on account of the different conditions of each town.

TABLE II.—*a*.

City.	Sewered area.	Population contributing to sewers.	Density per acre of sewered area.	Length of sewers.		
				Total.	Per inhabitant contributing to sewers.	Per acre of sewered area.
	Acres.			*Miles.*	*Feet.*	*Feet.*
London	60, 000	4, 200, 000	70	2, 276	2. 86	200
Paris	18, 000	2, 000, 000	111	393	1. 04	115
Berlin (Rad system. III.)	964	110, 000	114	49. 3	2. 37	270
Vienna	15, 500	1, 000, 000	64	142	. 75	49
Liverpool	6, 800	680, 000	100	668, or 350 excluding sewers in back passages.	5. 18, or 2. 47 excluding back drainage.	519, or 247 excluding back drainage.
Hamburg	7, 500	374, 000	50	131	1. 84	92
Frankfort	1, 300	95, 000	73	69. 6	3. 87 2. 90 (estimated when all houses are connected).	283
Danzig	1, 200	80, 000	67	25. 8	1. 71	113

TABLE II.—*b*.

City.	Cost of—				Pumping per head per annum proportioned to population for which sewage is pumped.	Remarks.
	Construction.		Annual maintenance, excluding pumping.			
	Per foot including appurtenances.	Per inhabitant now contributing to sewers.	Per foot.	Per inhabitant contributing to sewers.		
London	Main drainage, including pumping-stations $53 00 Valley-line sewers 12 30 General average 5 68	$16 00	$0. 060	Main drainage $0.03 Other sewers 0.14 Total 0.17	0. 08	Sewage pumped, 18–36 feet.
Paris	Common sewers 9 50 House branches 3 00 Average (excluding house branches and including appurtenances) 9 62	10 00, excluding house branches.	0. 130	0. 135	0. 08	System not quite completed. Sewage pumped, 36 feet.
Berlin (Rad system. III.)	Average (including pumping-station) 5 80 3′ 3″×2′ 6″ sewers 5 40 Pipe sewers 2 75	13 75	0. 043	0. 101	0. 158	Sewage pumped, 72 feet.
Vienna	Average 6 10	4 60	0. 093, including considerable repairing.	0. 070		System not quite completed.
Liverpool	3′×2′ sewers 5 00 Average 3 70	19 00	0. 029	0. 147		Sewers in back passages are about 350 miles long. Average cost of remaining sewers, per foot, is $6 50.
Hamburg	Average 6 10 Mains 22 50 Branches 3 90	11 25	0. 036	0. 066	0. 10 ?	
Frankfort	Average 5 71	22 10 16 58, estimated when all houses are connected.	0. 035	0. 137 0. 103 estimated when all houses are connected.		Only about ⅔ of population on the line of the sewers contribute to them.
Danzig	Average 3 65	6 25	(*)	(*)		

* Maintenance and pumping are under contract, in compensation for free use of farms.

The *length of sewers* per inhabitant making use of them is given as it exists at present. Yet without some explanation it may mislead.

The figures for London, Berlin, Liverpool, Hamburg and Dantzic apply to areas where the sewers are complete and where practically every house is connected. Among these the figure for Liverpool is very high, because it includes the sewers in back passages, which in other cities are partially represented by private house drains. Deducting these, the length reduces itself to one not essentially varying from the rest. The system of back drainage, although it increases the length of public sewers, greatly diminishes the length of house sewers. The length in Frankfort is also proportionately high, but this is due to the fact that all houses on the line of the sewers have not yet been connected. It may ultimately be reduced about one-quarter. In Paris and Vienna the systems are not yet complete. The length per inhabitant is, therefore, small. After making these allowances it will be noticed that the length of sewers per inhabitant varies from 1.71 in Dantzic to 2.86 in London.

1. *Cost of construction.*

A great uniformity is visible in the price per foot of all the works, and whatever deviations there are from the general average may be readily explained. Paris gives the highest figure, $9.62 per foot, which is due not only to the large sizes of the sewers, but also to the more costly shape and construction. Dantzic, on the other hand, gives the least figure, and this is due to the fact that much of the rain-water does not enter the sewers, but flows off on the surface into the numerous water-courses intersecting the city, thereby permitting of smaller sizes than would otherwise be necessary. Liverpool, likewise, shows a small figure, because about three hundred and fifty miles of small back drains are included, which in other cities belong to the house drains proper, and are paid for privately. Calculating their cost at $2 per foot and deducting them, the average cost of the remaining sewers would increase to $6.50 per foot, which is quite near to the general average.

The remaining cities show little difference. They are similarly sewered with the combined system, and the cost varies only from $5.68 to $6.10 per foot.

When reducing the cost of construction per inhabitant using the sewers, the results are also interesting. Confining ourselves to those cities where practically all properties are connected, such as London, System III of Berlin, Liverpool, Hamburg, and Dantzic, we find that in London, Berlin, and Hamburg, where sewers are similarly proportioned and designed, the expense varies only from $11.25 to $16 per inhabitant. In Dantzic, again, with its small sewers not carrying much rain-water, the cost has only been $6.25 per inhabitant, whereas in Liverpool it reaches about $19. If we also, at this place, make allowance for the back drainage, the cost is reduced to $13.60 per inhabitant. The high figure for Frankfort is, again, due to the circumstance that not all of the properties along the line of sewers are connected. When this is done the cost will be about $16.58 per inhabitant.

2. *Cost of maintenance.*

Paris, as might be expected from the elaborate system of flushing and cleaning, gives the highest figure—namely, 13 cents per foot—for maintenance. Vienna follows with 9.3 cents, one-third of which, however, is devoted to repairs. From the many old and ill-shaped sewers, the expense of keeping them in order would naturally be somewhat high. London averages 6 cents, Rad. System III of Berlin 4.3 cents, and Hamburg 3.6 cents per foot, all excluding pumping. The low cost in the latter city is due somewhat to the excellent flushing facilities, in making use of the Alster lakes and canals for this purpose. The cost of maintaining the sewers of Frankfort is 3.5 cents per foot. Here, too, the flushing by means of subsoil water, collected and stored at the highest points, facilitates the cleaning. In Liverpool, finally, the expense for this purpose is about 3 cents per foot, including back drains. The sewers have good grades and do not appear to need much cleaning. Their condition, however, judging from the odor arising at the ventilators in the higher parts, can hardly be as good as in the above-mentioned cities.

In reducing the annual cost of maintenance per inhabitant using the sewers, excluding pumping, the results are as follows: In London the expense is about 17 cents per head; in Liverpool, 14.7 cents; in Berlin, 10.1 cents; in Hamburg, 6.6 cents. In Frankfort, when all houses are connected, the figure will be about 10 cents, judging from the present cost. In Paris the present expense for maintaining sewers is 13.5 cents. In addition to this it costs 55 cents per head to remove the night-soil. In Vienna the expense of cleaning sewers is 7 cents per head, and for the removing of night-soil 10.5 cents per head in addition. The last two cities plainly show the great expense of dry removal, or the economy of water carriage for large cities requiring sewers for house and rain water.

Finally, a general induction seems to be indicated by a comparison of the cost of sewerage works.

It appears that the expense of a system per inhabitant increases with the size of the city. This is, in fact, what might be expected, as the cost of removing other refuse and of supplying the various needs of a community to its inhabitants usually shows a similar increase.

Herein lies, perhaps, one cause of the frequency of inferior drainage arrangements in our large cities. While in a growing city we are always willing to increase the pay for immediate benefits, such as conveniences for our daily needs, we hesitate to increase it for what appear to be only remote benefits, such as the removal of waste matter. Only as the invisible dangers of the latter become distinctly recognized can it be expected that the proper proportion of money will be expended for it.

VI. DISPOSAL OF SEWAGE.

Whereas comparatively little has been written on the previous subjects, there exists a considerable amount of literature on this one, owing mainly to the controversies that have arisen regarding it. I shall therefore merely state the conclusions to which the opinions of those engaged with the subject converge, and which a personal inspection of the various methods and works warrant, adding a few elucidating remarks.

I. The expectations entertained for a long time that town sewage could be converted into a valuable manure, which would not only pay for the conversion but render it profitable besides, have been given up, save by a few parties interested in patent processes. The general opinion held at present is that sewage must, beyond all other considerations, be disposed of in a way which is least injurious to the community, that a pecuniary profit cannot be looked for in every case, and that essential differences in topographical, physical, and geological conditions will require essentially different modes of treatment.

II. When sewage can be safely discharged into a large river or the sea, this will generally be the most satisfactory and economical mode of disposing of it. This method is practiced in London, Vienna, Liverpool, Hamburg, and a large number of sea-coast towns, without presenting any objectionable features, care being taken that the sewage is not brought back to the towns by currents or winds. For tidal rivers it will be necessary to discharge it only at high tides and after, storing it during returning tide. Along the sea-coast it must be carried to a sufficient distance, so that the same end may be attained. Sea water offers greater difficulties in this respect than fresh water, as the sewage does not mingle with it as rapidly, floats on the surface for a long time, and is not as readily oxidized.

III. When sewage must be purified before it is discharged into a stream, the most satisfactory method is by means of *irrigation*, provided a sufficient amount of suitable territory and soil can be had at the price of good farming country.

The best examples of irrigation were found in Bedford, Doncaster, Croydon, Wrexham, and Leamington, in England; Dantzic and Berlin, in Germany, and in Gennevilliers, below Paris. The effluent was generally clear and in no way objectionable.

The soil for irrigation must be loamy, sandy, and porous. It must be deep-drained, and in such a manner that the sewage cannot reach the drains directly from the carriers. The quantity of land necessary varies with the soil, the season, and the crops, being one acre for one hundred to four hundred persons. A sewage farm requires not only much more attention than an ordinary one, but a considerable amount of skill. The most successful examples were those which received an intelligent supervision by specialists. The increased expenditure incurred through a sewage farm, however, can generally be covered in such cases by a greater abundance and better quality of the crops as compared with ordinary farms, especially when the soil in both cases is sandy.

IV. When sufficient land cannot be had for irrigation, on account of expense, &c., or during the winter months, when vegetation cannot absorb the sewage, *filtration* is sufficiently effective to purify it. During the winter it may be constantly applied; during the summer it should be intermittent. Examples are found at Kendal, Merthyr-Tydvil, and Abingdon, in England, and in the winter basins at Berlin.

The ground for this purpose must be a free soil, and the areas level, to allow the sewage to stand and gradually soak away. Here, too, the entire ground must be deep-drained. The effluent observed at Kendal and Abingdon in summer was clear, tasteless, and without odor. In Berlin during December the effluent from the winter basins, in which the sewage was standing eighteen inches deep, was clear, but retained a strong odor. The amount of land used for filtration is one acre for four hundred to eight hundred persons.

Irrigation and filtration are frequently combined for the same town, and this is especially advantageous where the winter climate is severe.

V. Where land is not suitable for irrigation or filtration, or where none can be had on account of topographical conditions or expense, sewage can be purified by means of *precipitation* with sulphate of alumina or milk of lime, with subsequent filtration on a very small area, through prepared basins if possible.

England is the only country which furnishes examples of this method, the best of which are at Coventry, where the precipitant is sulphate of alumina, copperas, and lime, at Bradford, where it is lime alone, and at Aylesbury, where it is sulphate of alumina, clay, and charcoal, with a trace of blood. (A B C process.)

The effluents in each case are tolerably pure. The precipitate, or sludge, varies in value according to the chemicals employed. Lime gives it the least value, the Bradford sludge being given away to the neighboring farmers, who cannot even use it all. Sulphate of alumina is richer, yet at Coventry it does not command a ready sale. The Aylesbury sludge, owing to the large amount of animal charcoal added to it, has the greatest value, but it is at the same time the most expensive to produce. The expense of the precipitation varies with the particular method, the locality, and the degree of purity to be attained.—(See Robinson, "Sewage Disposal," London, 1880.)

VI. It may finally be said that an absolute standard of purity for the effluent should not be given, but that its degree should depend on local conditions, on the size of the sewer, on the use to which its water is thereafter to be put, and on the distance from the next town. In many cases it will even suffice to purify only a portion of the entire sewage of a town, the rest not being considered objectionable in the river. Although the cost of sewage purification is greatly modified by local conditions, it will be found in general to increase as land becomes less available or in the order given above. As the expense of land near a city generally increases in proportion to the size of the latter, the cost of purification per head of population will, *cæteris paribus*, be more expensive for large towns than for small ones.

Respectfully submitted.

RUDOLPH HERING,
Civil and Sanitary Engineer.

APPENDIX NO. 1.

Tabular arrangement of data relating to the sewerage works of eleven European cities.

SCHEDULE OF HEADINGS FOR EACH CITY.

A.—Statistics of locality.
- 1. Population.
- 2. Area.
- 3. Number of dwellings.
- 4. Water supply.
- 5. Mortality.
- 6. Meteorological.
- 7. Topographical.
- 8. Physical.
- 9. Geological.

B.—Management of public works.

C.—Design and construction of sewerage works:
- I. General system and alignment.
- II. In streets, etc.
  - 1. Shape and size of sewers.
  - 2. Depths and grades.
  - 3. Junctions, connections, overflows, and outfalls.
  - 4. Ventilation.
  - 5. Man and lamp holes, and flushing shafts.
  - 6. Gullies.

7. Pumping stations.
8. Miscellaneous structures.
9. Materials and construction.
10. Statistics.

III. In houses.
IV. Disposal of sewage.

D.—Maintenance of sewerage works.
1. Appliances.
2. Method.

E.—Cost of sewerage works.
1. Management and maintenance.
2. Construction.

CITIES: London, Paris, Berlin, Vienna, Liverpool, Hamburg, Frankfort-on-the-Main, Dantzic, Brighton, Oxford, Amsterdam.

LONDON.

A.—STATISTICS OF LOCALITY.

1. *Population.*

Drainage and water-supply district, 4,343,400. Average density, 55.6; varies from 42 to 174 per acre.

2. *Area of metropolis.*

122 square miles = 78,080 acres. Greatest length, 14 miles; greatest width, 8 miles.

3. *Number of dwellings.*

In drainage district, 585,000. Number of inhabitants per house, average, 7.4.

4. *Water supply.*

	Gallons.
From rivers Lea, Thames, and chalk wells per day	145,800,000
From chalk wells, per day	9,140,000
From river Lea, per day	61,989,000
From river Thames, per day	74,614,000
	145,743,000

81 per cent. used for dwellings; 19 per cent. for streets, fountains, &c. Average, 32.7 gallons per head. All river-water is filtered.

5. *Mortality.*

1840–1849	25.1	1850–1859	24.1
1860–1869	24.3	1870–1879	23.0

6. *Meteorological.*

Temperature:

	Fahrenheit.
Thirty years mean annual	49.4
Mean monthly maximum	72.3
Mean monthly minimum	32.7

Maximum seldom above 80°, though it has reached 94°.
Minimum seldom below 15°, though it has reached —5°.
Mean daily range, 16.9; mean monthly range, 36.8 Fahrenheit.
Frost penetrates soil to a maximum of 2 feet.
Rain, annual, from 18 inches to 30 inches.
Thirty years mean, 24.4 inches.
Number of rainy days per year, 170.
Mean humidity, 81.
Rain storms, maximum:

	Inches per minute.
1846, August, 3″.3 fell in 140m; 2″ in 30 minutes	.067
1852, July, 0″.5 in 15m	.033
1857, October, 2″.92 in 36hrs	.0013
1874, May, 0″.34 in 8m	.043
1874, June, 0″.96 in 30m	.032
1874, July, 2″.23 in 84m	.027
1878, June 23, 3″.00 (nearly) in 90m	.033
1878, April 10 and 11, 2″.64 in 19hrs, maximum in 90m.	
1880, July 14, 0″.36 in 12m	.030

7. *Topographical.*

Situate on both banks of the Thames forty miles above its mouth. Largest area is on the northern bank, where the surface is above floods, slightly undulating and rising toward two prominent elevations (Highgate and Hampstead) near the northern municipal boundary. Southern bank is low, with districts below ordinary high water, gradually extending to high and hilly grounds near the southern boundary. Old water-courses of creeks are either sewered or kept free from pollution, such as the creek flowing through the "Serpentine." City datum: 12.50 feet below Trinity high-water mark. Average tide in Thames, 18 feet. At Barking and Crossness outfalls mean low water is —7.6; mean high water is + 10.72.

Extreme tides:

1874, March 20	high water + 16.50
1874, April 18	high water + 16.00
1874, October 21	low water — 10.00
1875, November 15	high water + 16.83
1877, January 2	high water + 16.50
1877, January 31	high water + 16.00
1877, October 8	high water + 16.00

8. *Physical.*

Greater part of metropolis is closely built up, especially older portions of the center, north, and south of river. West and northwest contain many open areas, parks, and gardens. Total length of streets is 2,600 miles, of which

1,338 miles are paved with macadam and partially granite blocks,
274 miles entirely with granite blocks,
23 miles with asphalt, and
15 miles with wooden blocks.

9. *Geological.*

The Metropolis is underlaid by chalk, cropping out near Lewisham and Deptford. Above it are beds of pebbles, sands, clays, and loams (Lower London tertiaries) of varying thickness, more or less permeable and furnishing water supply. Outcrops are in the Isle of Dogs, Stratford, Dulwich, Peckham, Greenwich, and Woolwich. Above them is London clay, which underlies in varying thickness the greater part of London, and comes to surface in northern and southern parts. On this lies the valley drift, consisting of brick-earth, gravel, and sand. It forms the surface of a large part of the metropolis, and carries much water, which supplies all shallow wells. A small portion is built on alluvium, covering the former; and a few small districts are, more or less, built on made ground.

B.—MANAGEMENT OF PUBLIC WORKS.

They are in charge of a *Metropolitan Board of Works*, an elected body of forty-five members, each serving three years. The metropolis is divided into *vestries*, larger ones sending one representative and some two, smaller ones combining into *districts*, with one representative. The board is thus formed of representatives from twenty-four vestries and fifteen districts. Chairman is elected from their number. Duties consist in supervising all main public works, among which is the main drainage system in design, construction, and maintenance. Board levies rates and borrows money for their purpose. All main sewers are both designed and built by the board. Ordinary sewers in each vestry and district are built by *district boards*, which have each an engineer and surveyor, with necessary corps of assistants. But all their plans must previously be submitted to the Metropolitan Board for approval. Permanent staff of Metropolitan Board of Public Works, engineer's department:

Main office:
1 engineer in chief.
2 assistants to chief.
1 principal clerk.
16 engineers and draughtsmen.

Flushing staff:
5 inspectors.
8 clerks.
18 gaugers.
107 flushers.
36 sluice and flap keepers, mechanics, and laborers.

Pumping stations and outfall:
4 superintendents.
126 mechanics and laborers.

C.—DESIGN AND CONSTRUCTION OF SEWERAGE WORKS.

I. GENERAL SYSTEM AND ALIGNMENT.

Combined water-carriage with interception of sewage and slight portion of rain, at several levels, discharging it ten miles below city into the Thames at outgoing tides. The valley line sewers, mostly old, receive excess of storm-water either direct or from overflows, and discharge by shortest line to the river. The Thames divides the system into two independent parts.

In the north there are three main intercepting sewers: The high, mid, and low level, and a few lateral branches, with final outfall at Barking. The high-level sewer begins south of Highgate, extends eastwardly to the valley of Hackney Brook, and crosses Victoria Park to Old Ford. The mid level begins near Harrow Road, passes under Paddington Canal, follows Uxbridge Road, Oxford street, Old street, Victoria Park, and joins the high level at Old Ford. These two sewers intersect all sewage that can flow into the Thames by gravity. A branch from the elevated grounds at Piccadilly joins the mid level. From Old Ford to Barking, the two sewers are united in one embankment, built for them on account of the low grounds, and form the

northern outfall sewer. At Barking a reservoir of $9\frac{1}{2}$ acres, and 6,700,000 cubic feet capacity, collects and holds all the sewage during incoming tides. The low level sewer begins at Pimlico, runs under the Thames embankment to Blackfriars, thence to Tower Hill and Abbey Mills, where its contents are raised 36 feet by steam-power, and discharged into the outfall sewer just mentioned. Several branches are connected with the low-level sewer, as follows; The Hackney, from the low grounds near the river Lea and the Isle of Dogs branch, both of which discharge into the low level at Bromley; also, the western low level, with branches from Acton, Chiswick, and Fulham, joining the main low level at Pimlico, into which its contents are discharged, after being lifted $17\frac{1}{2}$ feet. South of the Thames there is a high-level and a low-level intercepting sewer, with final outfall at Crossness. The high level is formed of branches from the Crystal Palace, Upper Norwood, and Balham Hill, skirting the higher grounds and uniting at Deptford, and then continues its course to Crossness as the southern outfall sewer, where the sewage is raised 10 to 30 feet high into a reservoir, from which it is discharged during out-going tides. The low-level sewers, one beginning at Putney and the other at Bermondsey, unite at Deptford, where their sewage is pumped 18 feet into the outfall sewer just mentioned. When crossing these intercepting sewers, the old valley-line sewers are connected with them to take the storm-water overflow and lead it directly into the river. At present several extensive overflow-sewers are being built in addition in various sections. The daily amount of sewage intercepted by the main drainage works is about 10,000,000 cubic feet north and about 4,000,000 cubic feet south of the Thames. The united capacity is 63,000,000 cubic feet, including a rainfall of $\frac{1}{4}$ inch in 24 hours. The system was designed by Sir J. W. Bazalgette.

II. IN STREETS, ETC.

1. *Shape and size of sewers.*

London exhibits a greater variety of shape in its sewers than any other city, representing as it does the ideas of several centuries. At present the following forms are used: Circular, for pipe sewers which rarely exceed 18 inches diameter, and for certain intercepting sewers. The egg-shape is common for all brick and concrete sewers, except those for interception and storm-water. The oval form, having a larger invert radius, is used when a comparatively great ordinary flow is to be removed. Other forms, such as flat or slightly curved inverts, or railway tunnel sections, &c., are used for special purposes.

The sizes of sewers are partially calculated by formulæ, partially determined by other considerations. When providing for storm water, Hawksley's formula is generally used. If A = acres drained and N = length in feet in which the sewer falls one foot, the log. diameter in

$$\text{inches} = \frac{3\log. A + \log. N + 6.8}{10}$$, assuming a rainfall of 1 inch per hour.

When calculating the rain-water reaching sewers to be $\frac{1}{4}$ inch in 24 hours plus the sewage, which is done for the main drainage system, then Eytelwein's formula is used in the form:

$$\text{Vel. in feet per sec.} = \frac{9}{10}\sqrt{\text{mean hydr. depth} \times \text{twice the fall in feet per mile.}}$$

The amount of sewage calculated is one-half of daily amount, assumed at 34 gallons per head, therefore 17 gallons, to flow off in 6 hours.

The smallest sewers used are 9-inch pipes, but generally not less than 12 inches, in diameter. The smallest brick or concrete sewers are 2 feet by 1 foot 3 inches. In the City of London the ordinary sewers are usually of brick, 4 feet 6 inches by 3 feet and 4 feet by 2 feet 6 inches with a terra-cotta invert block of 10 and 12 inches radius. The northern high-level sewer ranges from 4 feet diameter to 9 feet 6 inches by 12 feet; the mid-level from 4 feet 6 inches by 3 feet to 12 feet by 9 feet 6 inches; the low-level from 6 feet 9 inches diameter to 10 feet 3 inches diameter. The southern high-level sewer ranges from 4 feet 6 inches diameter to 10 feet 6 inches diameter. The northern outfall has 3 sewers, each 9 feet by 9 feet, side by side. The southern outfall is $11\frac{1}{2}$ feet diameter.

2. *Depth and grades.*

The depth of ordinary sewers below the street surface is from 12 to 15 feet. Cellars and basements are from 5 to 10 feet deep and if deeper, sewage must be raised into the sewer by the private parties. When a sewer for purpose of grade is over 16 feet deep, a second one is built above it, to receive house connections. Grades for sewers are usually limited to give a minimum velocity of 18 inches per second. Grades of

Northern high level	1:71, then 1:376, finally 1:1100
Northern mid level	1:300 to 1:2640
Northern low level	1:1760 to 1:2640
Northern outfall, 1.2640 (invert at outlet is 18 inches below high water)	
Southern high level	1:176 to 1:2266
Southern mid level	1:100 to 1:2266
Southern low level	1:1320 to 1:2640
Southern outfall	1:2640

3. *Junctions, connections, overflows, outfalls.*

Junctions of sewers are generally made by easy curves, but there is no uniformity in the details. They are generally covered by a funnel arch, and have a tongue between the sewers. The chamber has a ventilator to the surface. House connections to sewers are made at an angle, either by blocks or slant pipes set into the brickwork. They are generally placed into the sewers when built. Overflows vary in design, and are generally placed at three-fourths of height of sewer. The mouth is wide, to take the water freely, and is then reduced to a circular or egg-shaped channel. Outfalls of main drainage sewers are at Crossness and Barking. At the latter sewage discharges by gravity. It is stored in covered reservoirs of $9\frac{1}{2}$ acres, and discharged only during outgoing tides. At Crossness the sewage is pumped into reservoirs of $6\frac{1}{2}$ acres, from which it is discharged also during outgoing tides.

4. *Ventilation.*

Sewers are ventilated by frequent openings into the street, generally by special shafts 6 inches, 8 inches, 10 inches, or 12 inches in diameter, terminating in the side of a basin, which is covered by an open grating. Man-holes are also often ventilating. Ventilation through soil-pipes is not generally indorsed, a disconnecting manhole between sewer and house with an open grate being preferred. Formerly the furnaces and stacks at pumping-stations were made use of for ventilation; but this is now abandoned, as it checks the draft, and is not efficient except for a short length of sewer. The odor in the old London sewers is very strong, as a rule; in the newer ones it is much less so. In a concrete sewer at Camberwell, built thirteen years ago, in which the sides are smooth and clean and the sewage was running swiftly, there was a scarcely perceptible odor six or seven days after the flushing. The odor at the pumping-stations is very slight, if at all noticeable, and is never objectionable. It is greatest when sewage runs very low—greater in dry than in wet weather, greater on Sundays than in the week. A very strong smell is always found at the screens where the floating solids are taken out; but the men who have been engaged at this work for many years remain quite healthy.

5. *Man and lamp holes and flushing shafts.*

Man-holes are mostly built with side entrances, especially in the central portion of the metropolis, having either vertical shafts or steps. When in the street, they are circular, and usually $2\frac{1}{2}$ to 3 feet in diameter, covered with a grating, partially open and partially with inserted blocks of wood to deaden the noise of passing wheels. The entrances, when on the sidewalk, are closed by a tight-fitting cover, which, when the man-hole is in use, remains raised up, and the opening is protected by an additional grate. The new man-holes for pipe-sewers are without a "drop" or basin, the pipe being carried through it, with a slightly increased fall, in semicircular sections, either straight or curved. Lamp-holes are 6 inches to 12 inches in diameter, and are occasionally used on pipe-sewers at bends. When ventilation is required a small basin to catch the street dirt is placed beside the shaft of the man or lamp hole, and through this the air passes out. It is about 9 by 18 inches, and is covered by an open grate, while the man-hole cover has no openings. Special shafts for flushing are sometimes placed at the upper ends of the pipe-sewers, and resemble the lamp-holes, but have a basin at the bottom to hold at least a cubic yard of water. Resting places for workmen are occasionally built on small sewers, 6 feet high and 6 feet long. They are ventilated.

6. *Gullies.*

The gullies are commonly placed under the gutter, the inlet being covered by a grating 16 by 18 inches, hinged. They are generally 4 feet deep and have almost always a catch-pit and a trap. The pipe leading to the sewer is 6 inches or 9 inches diameter. The trap is formed sometimes by a flag-stone 3 inches thick, let down from the top and sometimes by the outlet-pipe itself. The seal is about 12 inches. The grating has bars $1\frac{1}{2}$ by 4 inches deep, with spaces of $1\frac{1}{2}$ inches. They are not located at the street corners, but in the blocks, generally 200 to 300 feet apart. Some inlet-basins are of iron 33 by 21 inches and 3 feet below the grating. There are a few inlets which lead directly into the sewer without trap or basin, by 9-inch terra-cotta pipes.

9. *Pumping-stations.*

London has four large pumping-stations. They are at Deptford and Crossness on the southern side, and at Pimlico and Abbey Mills on the northern side of the Thames. The Deptford station is the oldest, having been in use 17 years. The sewage is raised 18 feet from the southern low-level sewer into the outfall. The inlet is a twin sewer, each 7 feet in diameter. The ordinary depth of water in them is 4 feet. There are 4 engines, each 125 horse-power. Amount of sewage which can be raised is 13,728 cubic feet per minute. The Crossness station is situated at the southern outfall. The sewage is raised from 10 to 30 feet either directly into the Thames or into storage reservoirs, of which there are 4, each holding 6,000,000 gallons,

and covering together $6\frac{1}{4}$ acres. The tide runs out 7 hours. Gates are left open 1 hour before to 4 hours after high tide. There are 4 engines, each 125 horse-power, driving 32 pumps and lifting ordinarily 106,400 gallons per minute. Diameter of pumps, $4\frac{1}{2}$ feet. Four have a stroke of 4 feet, and four have a stroke of 2 feet. The works are being extended. Amount of sewage which can be raised per minute is 17,028 cubic feet. The Abbey Mills station is situated on the line of the northern high level, where the sewage from the northern low level is pumped into it 36 feet high. The diameter of the inlet sewer is 10 feet 3 inches. There are 8 engines, each 142 horse-power, driving 16 double-acting pumps, raising ordinarily 96,000 gallons per minute. The amount of sewage which can be raised per minute is 15,000 cubic feet. The western pumping-station (Pimlico) is the most recently built. Here the sewage from west of Chelsea is raised into the northern low-level sewer. The inlet is 6 feet 9 inches diameter, with an ordinary depth of sewage of 3 feet. The lift is 17.8 feet (—19 to —1.20 below datum). During heavy storms the sewage is pumped into the Thames. There are 4 engines, each 90 horse-power, with a supplementary engine 120 horse-power. The engines drive 2 pumps each, of 5 feet $3\frac{1}{2}$ inches diameter and 4 feet stroke. Six thousand cubic feet of sewage can be raised per minute. In 1878 the engines at work, representing 2,620 nominal horse-power, consumed about 23,340 tons of coal.

8. *Miscellaneous.*

* * * * * * *

9. *Materials and construction.*

Materials used for sewers are brick, concrete, and terra-cotta pipe. Bricks are of the best stocks; the inverts are often built of or lined with Staffordshire blue bricks. Wedge-shaped bricks are generally used in small sewers. The arches of sewers up to and including 2 feet diameter have a thickness of half-bricks ($4\frac{1}{2}$ inches); invert masonry is always 9 inches thick. The inner surface of lately-built brick sewers presents a very even and smooth appearance. Concrete is preferred where not too expensive. Portland cement is used for it in proportions of 1:4 to 6 of Thames ballast (gravel and sand mixed), and allowed to set one week before centers of large sewers (6 by 4 feet) are drawn. Concrete sewers many years old presented a perfect condition with very little adhesion of sewage particles, and very little odor. Sometimes concrete sewers are lined with a $4\frac{1}{2}$-inch ring of brick. Pipe-sewers are very carefully laid; when ground is at all uncertain they are laid in a bed of concrete 6 inches thick all around the lower half. Stanford's patent joint is frequently used.

Mortar is made of Portland cement and a sharp, washed sand in proportions of 1 : 1 and 1 : 3, the former for inverts, the latter for arches. A yearly contract is given out for all work under £500. For larger amounts special specifications and contracts are made. All work is usually given out for a certain sum, with prices attached for variations of original quantities.

Before 1846 no sewers were egg-shaped, none were built of vitrified pipe, and none of half-bricks.

10. *Statistics.*

Ludgate Hill sewer was built before the year			1668
Fleet street sewer was built in			1668
First surveyor for London was appointed in			1768
Length of sewers:			
Up to 1855, inclusive	miles..		1,146
Up to 1856–1877, inclusive:			
Main drainage		82	
District sewers		857	
Reconstructed sewers		56	
			995
1878 to 1880, inclusive	miles..		135
Total length of sewers	miles..		2,276
Of which 550 miles are of vitrified pipe.			

Intercepting sewers:		
Northern high level, length	miles..	$7\frac{1}{2}$
Area drained	square miles..	10
Northern mid level, length	miles..	$9\frac{1}{2}$
Piccadilly branch, length	miles..	$2\frac{3}{4}$
Area drained	square miles..	$17\frac{1}{2}$
Northern low level, length	miles..	$8\frac{1}{4}$
Hackney branch, length	miles..	$2\frac{1}{2}$
Isle of Dogs branch, length	miles..	$1\frac{7}{8}$
Area drained	square miles..	11
Western extremity of northern low level, length	miles..	$5\frac{1}{5}$
Fulham branch, length	miles..	$1\frac{1}{5}$
Acton branch, length	miles..	$1\frac{3}{5}$
Area drained	square miles..	$12\frac{1}{2}$
Northern outfall sewer, length	miles..	$5\frac{1}{2}$
Southern high level, length	miles..	$5\frac{3}{5}$
Effra branches, length	miles..	$7\frac{1}{4}$
Area drained	square miles..	20
Southern low level, length	miles..	$9\frac{1}{4}$
Bermondsey branch, length	miles..	$2\frac{3}{4}$
Greenwich and Deptford, length	miles..	$1\frac{1}{2}$
Area drained	square miles..	20
Southern outfall sewer	miles..	$7\frac{1}{2}$
Area drained, additional	square miles..	2

Daily amount of sewage discharged into Thames from both outfalls, 17,600,000 cubic feet.

Deptford pumping-station was opened 1864.

Crossness pumping-station was opened April 4, 1865.

Abbey Mills pumping-station was opened July 30, 1868.

Western (Pimlico) pumping-station was opened August 5, 1875.

Number of gullies in 1878, was 67,491.

III. IN HOUSES.

No uniform system or regulations. The majority of houses (the older ones) are said to be improperly drained or connected with sewers. Lately plans are being submitted to the vestries for approval showing lines of pipes, closets, sinks, &c., on a scale of 8 feet to 1 inch.

Inspection shafts, disconnecting chambers, or man-holes are preferred between the house and street sewerage, so that no gases from the latter can enter the house pipes. These are usually outside of walls, especially the soil-pipe. Water-closets are said to be in every house, and cess-pools entirely abolished. Each receptacle of sewage is trapped. The following principles are recommended by authorities:

Pipes shall be of iron with leaded joints or of glazed stoneware, with socket-joints filled by cement. Neither shall be less than 4 inches diameter. Grade, if possible, 1:20; never less than 1:40. Drains are never to be under buildings unless embedded in concrete 6 inches all round and ventilated at each end. All branches must join obliquely in direction of flow. Every inlet is to be trapped, and every pipe trapped as near as possible to sewer. Two untrapped openings for ventilation to be as far as possible apart, one near the ground, and the other not less than 4 inches diameter, carried up at least 10 feet above ground or building. Soil-pipe to be carried up outside of building full size beyond the roof. No container or D-trap should be used. Waste-pipes, except from slop-sink, must not be connected with soil-pipe or pass to the drain, except first through a gully outside the building, and which is trapped against and disconnected with the sewer. It is to have an open grate or be specially ventilated. No drain connected with any cesspool should be connected with any pipe leading to sewer.

IV. DISPOSAL OF SEWAGE.

The metropolitan sewage is discharged into the Thames at Barking and Crossness, 10 miles below the city. It is temporarily stored in reservoirs during incoming tides. Velocity of water in Thames, average, $4\frac{1}{4}$ inches per second.

	Reservoir.		Discharge.	
	Area.	Capacity.	Daily sewage.	Maximum rain-fall.
	Acres.	*Gallons.*	*Cubic feet.*	*Cubic feet.*
Barking	$9\frac{1}{2}$	45,000,000	11,600,000	28,500,000
Crossness	$6\frac{1}{4}$	24,000,000	6,000,000	17,200,000

D.—MAINTENANCE OF SEWERAGE WORKS.

1. *Appliances.*

Sewers are cleaned generally by flushing. Old sewers with flat inverts, and new ones when accidental obstructions occur, are entered and cleaned with scrapers and shovels. Pipe-sewers, when they become obstructed, are cleaned with circular brushes drawn through them, or by jointed hooks, which are closed when pushed in, and are forced open by a spring when drawn back. For flushing the pipe-sewers, either flap-valves are used or such as work in a groove, regulated from above to dam the sewage or flushing water. Large sewers have penstocks inserted at necessary intervals. They are generally worked from above, and consist of a heavy door either drawn upward or swinging to one side. The pumping-stations also have penstocks to hold the sewage back temporarily or to regulate the discharge into the river or to the pumps.

The gullies are cleaned regularly and often. The scoops used have a flat or semicircular bottom.

2. *Method.*

Prior to 1871 the cleaning of the main valley-line and intercepting sewers (about 250 miles) was done under contracts. After careful

inquiry it was then decided to have it done by a staff of men appointed by and under the direction and control of the board. (See B.) Ordinary sewers are maintained by the district boards and vestries. The sewers are regularly inspected at different intervals, and flushed or cleaned when necessary.

In 1878 there were taken out of sewers 723,000 cubic yards deposits. In 1878 there were taken out of gullies 100,050 cubic yards silts.

Every year a contract is given out for repairs or new works under £500 in value. Special contracts are made for works over this amount.

E.—Cost of Sewerage Works.

1. *Management and maintenance.*

Engineer's department for 1879:	Number of employés.	Total salaries.
At main office	32	£12,200
Pumping-stations	127	11,186
Sluice and flap keepers	48	3,493
Clerks of works, &c	10	1,822
Flushing inspectors, foremen, and men	144	10,301
Chairmen, &c	10	790
		39,790
Or about		$195,000

Cost of pumping-stations for 1879.

Wages	£9,689
Fuel	18,204
Repairs	8,098
Miscellaneous	2,870
	39,041
	$191,000

Cost of sewerage works under metropolitan board in 1879.

Wages of inspectors, sluice and flap keepers	£4,000
Construction	2,200
Repairs (including hedging and ditching at Barking)	7,215
Cleansing (including wages)	14,550
Incidentals	630
Ventilation and deodorizing	350
Rent and taxes	120
	29,065
	$142,400

Total cost of maintaining sewerage works under metropolitan board, including engineer's department, £80,000 = $392,000.

Municipal expenses are paid out of a rate, a tax upon real estate. It is about $3.25 on the $100. The maintenance of all the London sewers costs about 25 cents per head per annum, including pumping, which is about 8 cents per head.

2. *Construction.*

Main sewers are constructed by the board and are paid for out of rate. Small sewers are generally paid for by the private parties benefited, and the greater number are also built by them. The total amount of money applied by the board to intercepting sewers and main sewers since consolidation has been £5,607,435 = $27,500,000. This includes 82 miles of main intercepting drainage and 58 miles of main valley line sewers, making 140 miles. Average cost of main drainage per mile is $280,000; of the main valley line sewers per mile, $65,000. The cost of the western (Pimlico) pumping station was $900,000, including ground, of which $283,000 were for boilers, pumps, and engines.

PARIS.

A.—Statistics of Locality.

1. *Population.*

In 1880, 2,100,000; average density, 96 persons to 1 acre; the old city has as many as 313 to 1 acre; the outer districts, Gobelins and Observatoire, 45 and 61, respectively, per acre.

2. *Area.*

Inside of fortifications	acres..	19,281
Circumference, 33,330 meters, or over	miles..	20
Greatest breadth from north to south	do ...	5½
Greatest breadth from east to west	do ...	7
Areas covered by public streets	acres..	3,706
Areas covered by rivers or quays	do ...	1,087
Areas covered by cemeteries	do ...	222
Houses, parks, and gardens	do ...	14,268

3. *Dwellings.*

Number of private houses, 74,740, containing 685,000 dwelling rooms and 337,600 shops and work-rooms. Number of inhabitants per house, 30.8.

4. *Water supply.*

Average per day:

Watering and washing streets	gallons..	28,713,200
Watering and sprinkling parks	do....	9,477,740
Fountains	do....	10,706,400
Public buildings, hospitals, &c	do....	11,474,720
Private dwellings	do....	33,141,960
Total	do....	93,514,020
Minimum	do....	78,714,000
Maximum	do....	104,600,000

This quantity is divided up as follows:

Vanne (spring)	gallons..	26,414,000
Dhuys (spring)	do....	6,603,000
Ourcq (creek)	do....	34,338,000
Marne (river)	do....	13,207,000
Artesian wells	do....	184,900
Seine (river)	do....	23,772,700
Supply not sufficient; it is desired to have	do....	132,000,000
Present average, per head	do....	50.2
Present average, per head of spring water (Vanne and Dhuys)	gallons..	15.6

which is intended for house supply only.

5. *Mortality.*

Mean for ten years	23.9
In VII Arrondissement (Elysée) it is	14.0
In XIII Arrondissement (Gobelin) and XIV (Observatoire)	39.0

6. *Meteorological.*

Temperature:

	Fahrenheit.
Sixty years mean	+51.44
Highest known temperature, August 26, 1765	+104.00
Lowest known temperature, January 25, 1795	−10.30
Mean of yearly maximum for 180 years	+91.22
Mean of yearly minimum for 180 years	+14.36
During last 90 years average number of days in a year when the thermometer was below freezing	46.5
During last 90 years average number of consecutive days of frost per year	14.4

Depth of frost: Mean, 8 inches; maximum, 31 inches.

Rain:

Mean annual	inches..	23
Minimum annual, in 1733	do....	8
Maximum annual, in 1804	do....	27½
Average number of days per year when rain falls is		253
Mean humidity		69.0

Maximum rain storms: In summer often ⅜ inches fall per hour.

1860, July 16, 38 millimeters in 20 minutes = .0750 inch per minute.
1865, May 23, 26 millimeters in 20 minutes = .0520 inch per minute.
1866, July 16, 32 millimeters in 30 minutes = .0424 inch per minute.
1867, September 20, 41 millimeters in 20 minutes = .0810 inch per minute.
1870, May 22, 26 millimeters in 60 minutes = .0172 inch per minute
1872, July 27, 40 millimeters in 60 minutes = .0263 inch per minute.
1879, August 15, 16.3 millimeters in 40 minutes = .0164 inch per minute.

Prevailing winds, southwest.

7. *Topographical.*

Situate on both banks of the Seine, 110 miles in a direct distance from its mouth and a little below its confluence with the Marne. Largest part of the city is on the northern bank. This is also more undulating than the southern. The highest points are: The Places de Montmartre, de l'Etoile, du Roi de Rome, the Buttes Chaumont, and the heights of Belleville. The south side falls more gradually to the river, with an average slope of 1:130. Altitude of the Seine at Paris is 80.5 feet above the sea. No part of the city is flooded by high water; both shores have stone embankments through the city. Fall of river at low water when discharge was 1,695 cubic feet per second: for eastern extremity of Paris, 1:19,483; for center of Paris, 1:1243; for western extremity of Paris, 1:14,225. Flood discharge March, 1876 (highest), was 56,500 cubic feet per second.

8. *Physical.*

Older part of city is very closely built up, especially towards the north and south. The western part has broad streets, avenues, parks, &c. Length of streets, boulevards, &c., is: with trees, 136 miles; without, 415 miles. Area covered by streets, see A 2.

B.—Management of Public Works.

All public works are under control of an inspector general and director, with a general office and corps of 26 persons. The main

departments, each one of which has a chief engineer and a large corps of assistants, are as follows:

I. *Streets.*—For the general design and laying out of the city, its streets, parks, &c.; also for the registry of real estate property; also for the construction and cleaning of streets. Corps: 45 persons for design and registry; 314 persons for supervision, construction, and maintenance.

II. *Lighting the city.*—Corps: 50 persons for design, construction, and supervision.

III. *Parks and boulevards* (landscape gardening).—Corps: 165 persons for design and maintenance.

IV. *Water supply and sewerage.*—Corps for general offices: 211 persons for design, construction, and maintenance.

a. Water-supply: Chief engineer and corps.

b. Sewers, canals, and sewage farm: Chief engineer, consulting engineer, and corps for general work; special engineer for construction and maintenance of sewers and nightsoil service, with corps; special engineer for disposal of sewage and nightsoil, with corps.

V.—*Tramways.*—For construction and service of passenger railways of the city.

VI. *Architecture.*—For construction and maintenance of all public buildings, 13 consulting architects, 12 regular architects, 60 inspectors, &c.

Paris Budget for 1881.

		Francs.
Ordinary expenses:		
Interest on municipal debt, &c		99,308,308
Police		22,820,568
Public schools		15,343,118
Public charities and pensions		16,202,973
Contribution for maintenance of army		2,944,800
Interments		1,135,308
Public works:		
General office	1,717,600	
Architecture and fine arts	4,669,200	
Public highways	22,312,050	
Promenades and lighting	8,901,980	
Water and sewer department	11,446,460	
		49,047,290
Other expenses		22,893,088
Total		229,695,453
Extraordinary expenses:		
New streets and pavements		2,480,000
New buildings		3,960,000
Other expenses		4,040,000
Grand total	francs	237,295,453
	or	$47,479,091

C.—Design and Construction of Sewerage Works.

I. GENERAL SYSTEM AND ALIGNMENT.

Transitional state at present. Four-fifths of all excrementitious matter is collected in water-tight vaults (fosses fixes) or in movable casks (fosses mobiles) and is periodically removed to a distant locality. The remaining quantity, which is increasing, is collected in casks (fosses filtres) which retain solids but permit liquids to escape and flow into sewers. They are exchanged at less frequent intervals and their contents disposed of in a similar way. All waste water from houses and streets, together with rain, are carried into a system of sewers. Its extent, as a uniform system throughout, excels that of any other city. Paris is divided into three main drainage-areas from which the sewage is carried entirely out of the city, and each one of which has a main collecting or intercepting sewer (collecteur général). The northeastern area is drained by the Collecteur du Nord, which begins near the Père la Chaise cemetery, passes the Buttes Chaumont and Montmartre, and terminates in two branches, one at St. Ouen and one at St. Denis. At St. Ouen it has an elevation which permits the sewage to flow across the Seine and to the irrigation fields at Gennevilliers by gravity. The central and main area is drained by the Collecteur d' Asnières, which begins at the arsenal in the east of Paris, follows the right bank of the Seine to the Place de la Concorde, and then crosses through the city to Clichy, where its contents are now partially (and will be entirely) pumped with a head of thirty feet through cast-iron mains to the irrigation fields between Asnières and Gennevilliers. The southern area, consisting of the entire city south of the Seine and the eastern end of the city north of it, is drained by the Collecteur de la Bièvre, which begins back of the Jardin des Plants, follows the left bank of the river to the Pont de l'Alma, crosses it there by an inverted syphon, and joining the Collectueur d'Asnières at Levallois-Perret, discharges at Clichy, respectively on the irrigation fields. Besides these main collectors there are about sixteen secondary ones discharging into them. The remaining are the "ordinary" sewers. In all streets above 65.5 feet in breadth double lines of sewers are built, one under each sidewalk, and in narrower streets they are built in the center. The ordinary sewers follow the valley lines as much as possible, and are all large enough to be walked through. No pipe sewers are used. The entire system was designed by M. Belgrand.

II. IN STREETS, ETC.

1. *Shape and size of sewers.*

The smaller or ordinary sewers have a shape approaching the oval, but with a flat, segmental invert, varying from 16 to 24 inches in width. The larger sewers or collectors have a banquette on one or both of the sides of the invert (cunette) high enough to be above the ordinary flow and broad enough to be walked upon. The main collectors have an invert about 11 feet wide and 4½ feet deep, in which specially constructed cleaning boats (bateaux vannes) are floated. The secondary collectors have inverts 47½ inches wide and 31 inches deep, with iron rails at their edges upon which the cleaning-trucks are run. The arches of the sewers covering the invert (cunette) and banquettes are semi-circular. All sewers are built large enough for men to walk upright in them, even the house branches, which extend to the point where the vertical soil and other pipes descend. Pipes for the water-supply, pneumatic tubes, and telegraph wires are inside of the sewer and attached to the arch. The sizes are divided into various types numbered from 1 to 14 for the sewers, and from 1 to 3 for the house branches. The main dimensions are as follows, all in meters:

Sewers.

Number of type.	Height under key.	Width at spring.	Sectional area.	
1	4.40	5.60	18.76	Main collectors with foot-paths.
2	5.35	5.20	16.59	
3	3.90	4.00	11.81	
4	2.98	3.70	9.89	Secondary collectors with path and rails.
5	3.80	3.00	8.66	
6	3.15	2.50	7.04	
7	3.55	2.50	6.29	
8	2.80	2.30	5.02	
9	2.75	2.00	4.23	
10	2.40	1.75	3.24	Ordinary sewers, oval.
11	2.30	1.30	2.36	
13	2.10	1.30	2.15	
13*a*	2.00	1.05	1.65	
14	2.00	.90	1.44	

House branches.

Number of type.	Height under key.	Width at spring.	Width at bottom.	Used when length is—
1	1.80	0.90	0.60	Over six meters.
2	1.40	0.60	0.40	Between 2 and 6 meters.
3	1.00	0.60	0.40	Two meters or less.

The selection of a type for a certain locality is governed by the following considerations: When the grade is heavy, *i. e.*, over 1 to 100, the types Nos. 10 to 14 are considered sufficient to discharge any water that may enter them in any of the drainage areas. When the grades are small, the type is determined through the following formula, which is derived from Prony's formula: Mean radius × slope = coeff. × square of velocity, and the assumption that the greatest quantity of rain falling in Paris is 1.77 inches per hour and the time to reach the sewers is three times longer than the duration of the rain. A = drainage area; a = section of sewer; r = mean radius; s = fall per 1,000, all in metric measure; $a = \frac{0.0239A}{\sqrt{rs}}$.

When storm-water overflows can be had, proper allowance is made when using this formula.

2. *Depth and grades.*

The depth of the ordinary sewers, unless grade demands it otherwise, is regulated so that they get a covering of at least 20 inches, which brings their inverts at least 6 feet below the surface. The depth of the invert (cunette) is at least 1 meter for the types cleaned by boats and at least 31½ inches for those cleaned by the tracks. The grade of the ordinary sewers is generally the same as that of the street; it is often rather steep. The large collectors are very flat, and are not self-cleaning owing to the large amount of silt which is washed into them from the streets. Types 1 and 3, which are cleaned by boats, have

a fall from .0003 to .0005. Types cleaned by the flushing trucks can have grades as low as .0005, and as high as .005, beyond which their action is impaired. Sewers without rails that receive little water must have a fall of at least .002, but can be as steep as .05, and in short lengths even .08. It is preferred not to have a greater fall than .04. The sewers without rails are to be made as short as possible, so that the sediment can readily be pushed down to a sewer with trucks or boats, instead of being taken out on to the street. The grades of the Collecteur d'Asnieres are from .00125 to .00036; Collecteur de la Bièvre, .001 to .00034; sewer on the Boulevard de Sebastopol, .00068; sewer on the Rue de Rivoli, .00066 to .00024; sewer from Hotel de Ville, .000307 for nearly 4,000 feet. The ordinary grade for house branches is 0.03.

3. *Junctions, connections, overflows, outfalls.*

The junctions of large sewers are not made in the English or Frankfort manner, but are as a rule rectangular chambers with cylindrical arch. The curves of the types cleaned by boats must have a least radius of 197 feet; those cleaned by trucks on rails, 98 feet. In the latter case, if this radius can not be had, the line may be broken and a turn-table inserted for the truck. This is to be avoided, however, if possible. Sewers without rails may be joined at any angle. Whenever possible an extra fall is to be given at every junction, so that no backwater is caused in the smaller sewer. The grade of large sewers at their junctions is also determined by the necessity of having the banquettes on the same level; the cunette or invert will therefore drop correspondingly. When sewers without banquettes discharge into sewers with banquettes, their inverts must be 10 to 12 inches below the level of the latter. When two oval sewers join, a drop of 8 to 12 inches is given, if possible, to each. The highest ends of the sewers are placed as little below the surface as allowable. The house branches, at least 1 meter high, connect with the sewers generally at right angles, which does not seem objectionable, as the house sewage is usually brought to the main in terra-cotta pipes, bedded in the invert of the branch and discharged from a trap-basin (cuvette). These pipes receive the house water and the fluid excrements of the "fosses filtres" where these are used. The branches from the sewer extend under the sidewalk and often under the houses to the back yards. Storm-water overflows are placed along the river at a few places. There are three outfalls for the Paris sewage: one at Clichy, one at St. Ouen, and one at St. Denis, all on the banks of the Seine several miles below Paris. The outfall at St. Ouen is at an elevation to allow the sewage to run by gravity to the irrigation fields of Gennevilliers. The sewage from the lower areas discharges at Clichy at ordinary high-water level, and its contents are now partially being pumped to Asnières, Gennevilliers, &c. Arrangements are being made to pump all of the sewage in the future.

4. *Ventilation.*

The Paris sewers are ventilated through the street-gullies and the outfalls, and occasionally through pipes terminating at roofs of buildings. No objectionable odor arises from the gullies into the street, nor is there much smell in the sewers, except from some irregularity, which is quickly removed. The most noticeable sources of bad odor are the street-inlet branches, where the silt often lies several days before it is removed.

5. *Man and lamp holes, flushing shafts.*

Man-holes (branchements de regard) are always entered on the sidewalks, through side entrances to the sewer, never from the street. They are closed with a cast-iron cover, 2 feet 7½ inches in diameter, and are descended by iron steps, fixed in the wall every foot. The floor of the side entrance is, ordinarily, 1 foot above the invert of the sewer, and slopes toward it with a grade of 0.015. Sometimes, in larger sewers, carrying much water, stone steps are built instead. The height of the passage way is 6 feet 7 inches, its width at spring is 39 inches, at bottom, 20 inches. There are no lamp-holes or flushing-shafts. Man-holes are, generally, 164 feet apart, which is not varied from, except when near a sidewalk crossing.

6. *Gullies.*

Gullies (branchements de bouche) have side openings in the curbs, 39 inches long and 4 inches to 5 inches high in the centre and 2 inches at the sides. The curbstones are about 11 inches wide at the top, with a face batir of 1 inch. The depth of the gutter at the inlet is 6 inches to 8 inches; elsewhere it is from 3 inches to 6 inches. The water drops into a shaft, measuring 18 inches in the direction across the street and narrowing at right angles to it, from 39 inches to 20 inches at 5 feet below the surface. The branch to the sewer then slopes down to about 8 inches above the invert, with a width of 20 inches at the bottom, and is covered by a horizontal, semicircular arch, with a span of 31½ inches, joining with the arch of the sewer. The junction of the branch with the sewer is made so that the upper side is brought in at right angles to it, the lower one being curved with a radius of 5 feet to prevent the currents from meeting at right angles. The latter precaution is, however, not required for the largest types. In a few instances the gullies have catch-basins, (reservoirs de sable.) Such basins are only in the suburbs and at the highest parts of the drainage areas. Gullies are built at no regular distance. The flatter the grade the more frequently they are placed. They are not located at street corners, but in the block.

7. *Pumping-station.*

The pumping station is situated at Clichy, near the bridge crossing the Seine to Asnières. Its capacity is gradually being extended to correspond with the extension of the irrigation fields. The present works provide for only one-sixth of the sewage. There are two horizontal engines, one of 250 horse-power, the other of 150 horse-power. The larger one works two centrifugal pumps 71 inches diameter, one lifting the sewage 16½ feet, the other forcing it to an additional head of 20 feet. The smaller engine works two centrifugal pumps, 47¼ inches diameter. The larger engine raises 1,040,000 gallons per hour, in a day of fifteen hours, at a cost of 52 cents per 1,000 gallons raised 36 feet, with coal costing $6.30 a ton.

8. *Miscellaneous structures.*

The sewage crosses from the south to the north side of the Seine by an inverted siphon near the Pont de l'Alma. It is a double line of wrought iron tubes each 1 meter diameter (39½ inches), 556½ feet long, laid several meters below bottom of river. The head upon the siphons can be varied from 1.7 feet to 7.8 feet as it becomes necessary. No trouble has been experienced with it.

9. *Materials and construction.*

Sewers are built of bowlders of a coarse, gritty sandstone (*meulière*), found in neighboring diluvium. Lately, some have been built of concrete. Bricks are rarely used. Vitrified pipes are only used for house drainage. The *meulière* masonry, bedded at right angles to the inner surface, is plastered with rich Portland cement mortar to an exceedingly smooth and regular surface. The coating must have a thickness of at least ⅝ inch over the most projecting points of the masonry. The least thickness of coating of the invert and banquettes must be 1½ inches; the coating of the extrados of the arch must be ⅝ inch. The stones form only about 50 per cent. of the bulk of the masonry, and are intended to act rather as stones forming a concrete than to give much strength in themselves. The underground sewage carriers in Gennevilliers are built entirely of concrete; their strength is tested to a head of 26 feet of water. The material is composed of 3 parts cement to 5 parts clean gravel and 5 parts sand in volume. The concrete sewers are partially molded in the trench, and partially molded at the works and joined in the trench. The cement ordinarily used is the "Vassy;" the mortar is mixed in proportions of 1 part cement to 3 parts sand, and 2 parts cement to 5 parts sand; it is of excellent quality. The sewers when built of hydraulic lime receive an increase in the thickness of arch and sides of ⅓. Below subsoil-water, however, cement must be used in every case. All work is given out by contract. Sewers of fixed dimensions are paid for by the running meter, and unforeseen quantities are paid for according to itemized prices attached to specifications. The siphon at the Pont de l'Alma consists of two wrought iron tubes 1 metre diameter, ⅜ inch thick, butt-jointed, with rivet-heads on inside, and countersunk to present an even surface. The tubes are 2 feet 6 inches apart, and are entirely bedded in concrete 1 to 3 feet in thickness all around; above low-water they are surrounded by mason-work. The concrete was put in place between sheet-piles, which still form its sides, with riprap on the outside. The walls of street inlets and other appurtenances are also built of *meulière* bowlders, plastered to a smooth surface. Over the extrados of sewers the earth filling is generally 40 inches, in exceptional cases it is 20 inches in streets, and 5 inches on the sidewalks.

10. *Statistics.*

Area drained by main sewers	acres..	15,939
Length of sewers in 1880:		
Main and intercepting (collecteurs)	miles..	45
Branch (ordinaires)	miles..	348
Total	miles..	393
Number of gullies		7,877
Length of gully connections	miles..	25¼
Number of man-holes		10,692
Length of man-hole side entrances	miles..	14½
Length of house connections	miles..	87
Usual length of branches to gullies or man-holes	feet..	8 to 9
Length of sewers necessary to complete the system	miles..	261
The least grade of street gutters is		0.005
Main collectors:		
Collecteur d'Asnières (Type No. 1):		
Length	feet..	30,060
Area drained	square miles..	9.85
Collecteur de la Bièvre (Type No. 3):		
Length north	yards..	5,096
Length south	yards..	6,015
Area drained north	square miles..	8.69
Area drained south	square miles..	1.74

Collecteur du Nord (Type No. 5):

Length .... yards..	12,861
Area drained .... square miles..	4.63
Length of streets having double line of sewers..miles..	60

Estimate of daily amount of sewage discharged:

At Clichy .... cubic yards..	286,000
Collecteur du Nord .... cubic yards..	57,500
Total .... cubic yards..	343,500

Temperature (F.) of sewage, Seine, and atmosphere compared in 1876:

	Sewage.	*Seine.*	*Atmosphere.*
Maximum	72°.5	77°.0	82°.4
Minimum	36°.5	33°.0	15°.8

Maximum discharge at Clichy is at 11 a. m.; minimum, at 1 a. m.
Maximum discharge at St. Denis is at 9 a. m.; minimum, at 11 p. m.

III. IN HOUSES.

Various methods of removal are practiced. A large number of houses have water-tight cess-pools, from which the contents are removed by odorless excavators and taken to various establishments for utilization.

Another method is to collect the night-soil in movable casks (*fosses mobiles*), which receive solids and fluids as well, and which are exchanged at intervals varying from a few days to a few weeks. Their contents are taken to the same establishments.

A third method, the one which at present receives the indorsement of the city authorities, is to receive the night-soil into movable casks which permit the liquids to drain off (*appareils diviseurs* or *tinettes filtres*) and run into the sewers or cess-pools. The retained solids therefore need a much less frequent removal (average 24 times a year), and are finally disposed of as before. The casks stand generally in the house branches or passage-ways accessible from the sewers, or where none have been built, in vaults. The soil-pipe leading down to them is usually of iron, sometimes of terra-cotta pipe 7 inches in diameter. The other end is carried beyond the roof. The waste or rain-water is led down by another pipe (iron or terra cotta) not passing through the cask, but running into a terra-cotta pipe 8 inches diameter, along the bottom of the house branch to the sewer, with a grade of 1 : 33, and has a basin or running trap (*curette*) at the point of its discharge into the sewer. On its way there are numerous branches (about 10 feet apart) for inserting cleaning tools. The soil-pipe terminates in the casks, from which the liquids run into the horizontal branch just mentioned. A trap is placed in the waste-water pipe before it enters the horizontal pipe. A ventilating pipe, not less than 8 inches diameter, is carried from the arch of the house branch to a point not near any window, but generally above the roof. The *tinettes filtres* are made of galvanized sheet-iron of a cylindrical form, are 16 inches in diameter and from 26 inches to 29 inches in height. A sheet-iron plate, perforated with holes and sliding in and out of grooves adapted to the inner side of the *tinette*, divides it vertically into two unequal compartments, the combined liquid and solid excreta falling into the larger one. The use of water-closets is becoming more general.

Number of cess-pools, holding each about 4 cubic yards......	86,000
Number of movable receptacles—	
retaining both solids and fluids............	17,450
filtering liquids into sewers............	13,000
filtering liquids into old cess-pools............	10,000
	126,450
Number of houses connected with sewer by a passage-way or branch	25,238
by pipes............	1,050
Number of houses having night-soil service............	63,000
Daily amount of sewage discharged, cubic feet	9,288,165
Daily amount of night-soil removed, cubic yards............	2,150
amount from tinettes alone, cubic yards............	392

Since 1852 it is obligatory to build passage-ways from the houses to the sewer, varying from 7 feet 6 inches by 4 feet 3 inches to 3 feet 3 inches by 2 feet. At present the feasibility is discussed of using pipes 10 inches to 16 inches diameter. Since 1880, June 23, the "tinettes filtres" are obligatory for all new houses built on sewered streets. Since July 2, 1879, it is lawful for small houses to be connected with the sewers by iron or vitrified pipes 12 inches diameter with a least slope of 3%, except in streets where travel is great and where the subsoil is soft and uncertain. Exhaust-steam is not allowed to be discharged into the sewers.

IV. DISPOSAL OF SEWAGE.

The night-soil removed from cess-pools and in movable casks is disposed of at various points around the city, the most important being the municipal works at La Villette, where three-fifths of the total quantity is taken. Here the casks are placed upon canal-boats and towed to Bondy. The night-soil from cess-pools is delivered in large casks upon wheels, into which it is pumped at the houses. The contents are dumped into an extensive underground reservoir 108 feet by 105 feet by 13 feet deep, and the liquids, which are about six-sevenths of the mass including suspended particles, are pumped by a 25 horse-power engine into two iron conduits, 8 inches diameter each and 10,500 yards long, to Bondy. The deposited solids are then loaded into casks and taken there by boat. The establishment of La Villette is well kept, the cellars are washed daily and are well ventilated. At Bondy the contents of the casks are dumped into basins and allowed to dry. The liquids pumped are also allowed to precipitate any solids, the residue in both cases being manufactured into poudrette. The liquids are distilled, and by the aid of heat and the addition of lime-water the ammonia is disengaged and is converted into sulphate of ammonia. The yield varies from 13 to 20 pounds per cubic yard of liquid. The waste waters are dark brown, and are discharged into a sewer leading to the Collecteur du Nord at St. Denis. About 885 cubic yards of night-soil are daily taken to these various dépotoirs.

The sewage proper of Paris is delivered at three points along the right bank of the Seine, at St. Denis and St. Ouen, where, at the latter place, it has an elevation sufficient to cross the river on a bridge and flow to irrigation farms on the plains of Gennevilliers. At Clichy, it requires pumping and is raised under a head of 30 feet crosses the river on a bridge to Asnières, and thence flows to the fields. About 60,000 cubic yards in summer and about 40,000 cubic yards in winter are now pumped daily and utilized. The rest flows into the Seine, which is strongly polluted as far down as Epinay. About 120,000 cubic yards of silt, supposed to be deposited from sewage, are yearly dredged. The sewage is led along roads and paths over the flat and sandy surface of the Gennevilliers district in channels, partially under pressure and partially open. The former are built of concrete, and have valves on the surface from which the sewage can be drawn. The district, except a small portion where the experiments on part of the department are made, consists of private tracts, and the owners are at liberty to use the sewage as they desire, or not at all. The ground is quite sandy and gravelly and covered with a sterile soil. With the aid of the sewage it has increased in value so much that the annual rental of land under irrigation increased in the last five years from $17.28 to $36.00 per acre. The sewage is applied either as broad irrigation (en colmatage) or in furrows (en rigoles) between long narrow beds 3 feet in width. The latter is preferred. The position of the beds is changed every year, so that they are placed on the furrow of the previous year. The extension of the sewage carriers over the entire peninsula is gradually to be accomplished.

	Acres.
Irrigated surface in 1872	126
Irrigated surface in 1875	346
Irrigated surface in 1878	914
Irrigated surface in 1880	1,020
Area available	12,000
or one acre for 170 to 200 persons	

No ill effects have been caused by the irrigation works. Since they were started, a new village, Gresillons, has sprung up in the midst of the territory, with a death-rate averaging only from 19.5 to 25.3. Irrigation was begun in 1869. It is intended in future to purify the sewage more by filtration through the soil than by irrigation alone. The two methods will be combined, however, as much as possible.

D.—Maintenance of Sewerage Works.

1. *Appliances.*

a. For removing night-soil.—Cess-pools are cleaned by pumping the contents into cylindrical iron carts with a capacity of from 70 to 140 cubic feet. These, when full, are hermetically sealed and conveyed to the several depots, La Villette, &c., for disposal. The common "fosses mobiles" are strong wooden casks containing from 4 to 6 cubic feet. They are closed with a tight-fitting cover and taken to the depots in carts for disposal. The "tinettes filtres" are made of galvanized sheet-iron of a cylindrical form, 16 inches diameter and 26 to 29 inches in height, with a movable screen to separate the fluids from the solids. They are connected by a movable bayonet-joint with the soil-pipe and by a small movable india-rubber pipe with the branch from the sewer. They can thus be readily removed, and after being tightly closed are rolled under a man-hole, hauled up, placed upon a cart and taken to the depots for disposal.

b. For cleaning sewers.—The appliances are as follows:

The "bateau-vanne" is a boat with a movable apron or scraper (vanne) of the shape of the invert, but an inch or two smaller, perforated with three small openings and suspended at the bow so that it can be raised or lowered. When it is lowered to within a small distance of the bottom the water rises behind it and, besides propelling the boat, rushes with great velocity through the narrow opening and stirs up the sediment. This sediment as it accumulates in front of the apron is pushed forward by it through the rising head of water and thus brought to the outlet. It is used in types Nos. 1 and 3.

The "wagon à bascule," or tip-wagon, is a truck, into which the silt is thrown and carried to the outlet. The "wagon-vanne" is a truck running on rails about 4 feet apart, fastened to the edge of the

"piedroit" (path). It operates exactly like the boat, in having a movable apron in front, by which the detritus is pushed down the sewer. It is used on the sewers of types Nos. 2, 4, 5, 6, 7, and 8.

The "wagons ordinaires" are simple trucks for the sewers of an oval shape without banquettes, or types Nos. 10 to 18. The scrapers and shovels are used in the latter to loosen the deposit and load it into the trucks or push it forward into larger sewers. The scrapers are similar to the common hoe, with its edge fitting the curve of the invert. Brooms are used to clean the banquettes and side entrances. The sewers of types 10 to 18 are sometimes flushed by pen-stocks or timber sluice-gates, hinged at the side and worked from the top of a sewer through a man-hole. The siphon crossing under the Seine at the pont de l'Alma is cleaned by means of a ball of hard wood 53¾ inches diameter, 5.9 inches less than diameter of pipe, and weighing 187 pounds, which is passed through it at intervals, generally once a week. It is pushed along by the force of the water, and by being lighter it rolls along the soffit which increases the velocity of the water along the bottom and causes the sediment to be scoured up and moved toward the outlet.

At certain places there are recesses in the sewers for collecting the silt, which is then removed by the trucks ("wagon à bisculе").

2. *Method.*

a. Of removing night-soil.—As stated under 1, the night-soil is collected in movable casks or pumped from cess-pools and taken to La Villette or other dépotoirs where their contents are either removed from the city finally or made into poudrette. The exchange of the casks is very regular and at brief intervals, many arriving at the dépotoirs not more than half filled. They are all well cleaned before being replaced. There is comparatively great cleanliness in the entire operation.

b. For cleaning sewers.—The sewers having banquettes (Nos. 1 to 9) are cleaned mechanically by the flushing apron or scraper, the rest are cleaned by hand, the mud being either removed into a large sewer with trucks or boats, or out of man-holes into the street and loaded into carts. The water in the former case passes through the space between the scraper and the sides of the sewer, as well as through the small apertures in it, and creates so violent an agitation in front that all the solid matter is held in suspension and driven forward with the scraper itself. It sometimes happens that one passage of the boat or truck is not sufficient to remove all the silt, and a second one is necessary. When the flow is too slight to float the boat, the water is temporarily raised by dam-boards exactly fitting the invert. The boats and trucks are attended by three men working the apron or assisting the motion of the boat. About 2,500 feet can so be gone over in a day. The sewers are rarely cleaned before the mud is several inches deep. The motion of the flushing boats and trucks is hardly 1 to 2 inches per second.

Acids must be neutralized before being discharged into the sewers. Steam or fluids of a temperature greater than 86° Fahrenheit are not admitted into sewers.

The siphon at the pont de l'Alma is cleaned by passing the ball. It has been in use many years and given no trouble nor reason to anticipate any. There is a difference of level between the two ends of 1 foot 8 inches, and this difference can be increased to nearly 7 feet by damming up the water at the southern end. A great velocity for simple flushing and for passing the ball is thus obtained. After the ball is inserted at one end it requires generally but a few minutes to appear at the other, pushing the silt in front of it. With a head of 1 foot 8 inches its velocity is about 3 feet per second.

The flushing and cleaning is executed in ordinary times by 550 to 600 men, under the supervision of 22 "piquers," 25 overseers, 5 sub and 1 chief "controleur." The city cleans 21,500 out of the 23,600 house-connections.

The condition of the sewers is generally clean and no strong, disagreeable odor prevails, except in the sewer which brings the foul waters from the Bondy establishment. During the summer months visitors are weekly taken through the large collectors in a cleaning-boat.

E.—Cost of Sewerage Works.

1. *Management and maintenance.*

Department for sewerage in 1879:

Corps for design and construction	$193,936
Materials and labor (exclusive of new work)	973,900
146 persons for inspection of cleaning sewers and night-soil service	71,000
Extension and repairs to city sewerage	420,000
Construction of house branches	28,000
Maintenance of sewers:	
Public sewers, flushing, &c	243,200
House branches (reimbursed to city)	76,000
Public buildings, including night-soil removal	45,400
Dredging sludge from river	36,000
Miscellaneous	20,400
	421,000
Utilization of sewage at Gennevilliers	78,000

Department for water supply in 1879:

Total expense, 5,860,280 francs = $1,172,056.

Annual cost of cleaning sewers per head of total population, 12.5 cents.

Annual cost of pumping sewage per head of total population, 4.5 cents, or about one centime for one cubic meter pumped.

Annual cost of night-soil service per head of population, 55 cents, or $1.23 per cubic yard.

Annual cost of pumping night-soil to Bondy, 2.92 cents per cubic yard.

Annual cost of transporting casks to Bondy, 7.32 cents per cubic yard.

Soil-pipes in houses supplied with the filtering casks are taxed with $6 annually. The removal and exchange of one cask is charged to owners with 30 cents. There is an average of 6.3 exchanges per annum. Therefore annual cost is about $1.90. Proprietors pay for the construction of house branches. Cost of the sewage purification works from 1869 to 1880 was about $600,000. Cost of maintenance and studies up to 1880 was about $600,000.

Rent of ground before sewage irrigation (1868) per acre	$12.15
Rent of ground after irrigation:	
1872 per acre	12.80
1875 per acre	17.28
1877 per acre	24.00
1880 per acre	36.00

2. *Construction.*

Estimated cost of existing sewers is $20,000,000, including 355 miles of main and branch sewers and 123 miles of house branches.

Estimated cost to complete the system is $8,911,100.

Present contract prices of the different types, &c. (see C. II., 1), are:

a. Sewers, for

	Francs per meter.	Per foot.
No. 3	367.42	$22 40
No. 5	299.67	18 30
No. 6	241.93	14 75
No. 6, bis	258.82	15 80
No. 8	172.97	10 65
No. 9	149.02	9 08
No. 10	112.52	6 86
No. 12	97.11	5 92
No. 13	92.06	5 61
No. 13, bis	81.62	4 98
No. 14	77.45	4 72

b. House branches, for	
Type No. 1	4 47
Type No. 2	3 43
Type No. 3	3 13
Type No. 4	2 82
c. Man-holes, for	
Horizontal branch, 2 meters high	5 11
Shaft, square section	2 80
d. Street-inlets, for	
Horizontal branch, 0.80 to 2 meters high	3 76
Shaft, rectangular section	2 28

All prices under *a*, *b*, *c*, and *d* are for paved streets, for meulière masonry and cement mortar.

Cost of underground sewage carriers at Gennevilliers (concrete) is about 90 cents per running foot, excluding cost of excavation. Flushers are paid 60 cents to $1 per day. Foremen have salaries of $400 to $625 per year.

BERLIN.

A.—Statistics of Locality.

1. *Population.*

1840—300,000; 1860—600,000; 1880—1,118,630.

2. *Area.*

	Acres.
Municipal	15,629
Area of lowland	9,983
Area of highland	4,645
Area built up	6,450

3. *Dwellings.*

Number of houses, about	21,000
Number of dwellings to one house	11.5
Average number inhabitants per dwelling	4.6
Average number inhabitants per house	53

4. *Water supply.*

Pumped from River Spree, 31.7 gallons per head per day.

5. *Mortality.*

Average for a number of years, 30.6. There has been a gradual decrease from 1872, when it was 32.6, to 1879, when it was 27.7—the lowest rate since 1867.

6. *Meteorological.*

	Fahrenheit.
Temperature, mean annual	48.20
Highest monthly mean temperature, July, 1865	71.20
Lowest monthly means since 1740:	
January, 1838	13.96
January, 1848	14.99
January, 1823	11.24
Lowest daily mean, 1850, January 22	—2.44
Highest daily mean, 1865, July 20	85.18
Highest 5-day mean, 1868, August	80.66
Lowest 5-day mean, 1861, January	7.42
Warmest observed temperature, July, 1819	99.50
Coldest observed temperature, January, 1823	—28.06
Mean of January for 150 years is	29.66

Rain.—Annual mean, 22.32 inches; number of rainy days per annum, averaged for several years, 118.

Maximum storms July 11, 1858, 2.56 inches fell in 14 hours = .003 inches per minute; .80 inches fell in 20 minutes = .040 per minute.

Prevailing winds, west (decided).

Frost penetrates ground from 40 to 50 inches.

7. *Topographical.*

Situate on both banks of the Spree, a small river rising in Central Germany, and a few miles from its confluence with the Havel River. The largest part of the town lies on a sandy plain varying in elevation only from about 15 to 18 feet above low water. In the southwest part of the city there are areas varying 10 to 15 feet above low-water. The ground gradually rises as its distance from the river increases, especially towards the north, where it reaches +25 feet near the old boundary. It rises still higher at a few points both north and south. In the south there is a sudden elevation of +111 feet, called the Kreuzberg. Low water in the Spree is about 95 feet above mean tide in the Baltic. The discharge of the Spree, which averages from 100 to 200 feet in width, is at—

	Cubic feet per second.
Ordinary low-water	1,000
Extreme low-water	506
Ordinary high-water	2,000
Extreme high-water	4,808

The river runs through the city in several arms.

8. *Physical.*

The city is closely built up in the central and eastern section. The western contains the parks and villa-residences. The streets are comparatively wide, and are mostly paved with stone blocks. Recently asphalt is being much used.

9. *Geological.*

In the older city and lowland the surface to a depth of five feet is of recent formation, either dug over or filled in. Below is alluvial sand from eleven to forty feet thick, and below this is diluvial loam and coarse gravel, rising to the subsoil water-level at a few places in the lower city. Near the river there are occasional beds of peat and of infusorial earth in depths of eight to twenty-six feet. For building purposes these "pockets" have proved very troublesome. Toward the higher grounds the diluvium rises to the surface.

B.—Management of Public Works.

Each department is headed by a "Baurath," (chief engineer,) responsible to the municipal council. The design and construction of the new sewerage works are under a special and temporary department. For the latter, there is a central office for furnishing principal designs and deciding general questions. It is headed by a director and six assistants. Other matters and the execution of the works are in charge of division engineers, one for each main drainage area (radial system), who have each a corps of several assistants, according to amount of work. The works are directly superintended by an inspector and "conductors." Maintenance of sewers is very systematic. So far only Radial System III is finished. The pumping station engages 16 persons, the maintenance of the sewers of the district, 14 persons. The irrigation works are also in charge of the temporary sewer department, under 1 inspector, with 1 assistant and 40 sewage distributors.

C.—Design and Construction of Sewerage Works.

I. GENERAL SYSTEM AND ALIGNMENT.

Combined water-carriage and disposal on sewage farms. As all sewage requires pumping, and as the surface of the city is extremely flat and low, it is divided into 12 independent artificial drainage areas or districts to obtain better gradients and less depth of sewers. Each one is called a "radial system," and they are numbered from I to XII. The city proper is covered by five, I to V; the rest are peripheral.

The sewage from each district is collected at a lowest point, the pumping station, and from here raised through iron mains to either of two farms, one situated to the northeast, the other to the south of Berlin. The stations are situated at or near the river or one of its branches, and the sewers radiate from it over the district. At present only Radial System III is finished, I and II are nearly so, and others have been commenced. The pumps are intended to raise besides the sewage only a first flush of rain-water; therefore numerous overflows are provided to relieve the pumps of any greater quantity. On broad streets, over 60 feet in width, a sewer has been laid on each side. All sewers are as much as posible connected with each other, and temporarily separated only by valves, in order to avoid dead ends, to flush lower from higher mains (Lindley principle), and to permit the sewage to flow into other sewers in case of stoppage in any one. All pipe sewers are laid in straight lines between man-holes (Rawlinson principle). In general the sewers are divided into collectors, which are deep and built of brick, into pipe sewers for the branches and higher districts, and into storm-water overflows, for which partially old sewers were made use of. The present plan was adopted in 1873, after an inquiry of a commission appointed in 1867. The system is designed by Mr. Hobrecht.

II. IN STREETS, ETC.

1. *Shape and size of sewers.*

Circular pipe sewers are used up to 20 inches diameter. Brick sewers are egg-shaped, except some of the larger ones, which are circular, or flat elliptical for want of sufficient height under street. The width of the egg-shaped section is two-thirds its height. The pumping mains are of iron and 1 meter diameter each, except one, which is only three-quarters of a meter in diameter. The size of the sewers is determined by Eytelwein's formula in the following form, for meters:

Circular sewers, running full, $v=50\sqrt{\frac{r}{2}s}$

$$\text{Log. } D=2.0456+\frac{5\log. r+\log. s}{2}$$

Egg-shaped sewers, running full, $v=50\sqrt{\frac{4.594}{7.93}rs}$

$$\text{Log. } D=2.2426+\frac{5\log. r+\log. s}{2}$$

Egg-shaped sewers, $\frac{2}{3}$ full, $v=50\sqrt{\frac{3.023}{4.788}rs}$

$$\text{Log. } D=2.0803+\frac{5\log. r+\log. s}{2}$$

in which v equals velocity in meters per second; r is the mean radius; s the sine of the slope, and D the discharge in cubic meters per second. The quantity of rainfall used for calculation is $\frac{7}{8}$ inches per hour, of which $\frac{1}{3}$ is assumed to evaporate, $\frac{1}{3}$ to penetrate the ground, and the remaining $\frac{1}{3}$ (7 millimeters per hour) to enter the sewers.

The quantity of sewage estimated is 130 liters (30 gallons) per day per inhabitant, of which one-half runs off in 9 hours, and for 800 inhabitants per hectare (324 persons per acre). At present there are only half this number. The minimum size for pipe sewers is 8 inches; maximum, twenty inches. The brick sewers are classified into eleven types, varying from one meter to two meters in height.

2. *Depth and grades.*

The depth of cellars was regulated by the subsoil-water, which stands at + 1 meter above mean water near the river, and at +2.2 meters at the upper end of the lower city. Cellars must be 1 foot above subsoil-water level. Depth of pipe sewers varies from 1 meter to 4 meters below surface, and of brick sewers, which are laid deeper to act as collectors, from 2 meters to 5 meters. The latter are often below subsoil-water, and are made water-tight with great care. The grades are, as a rule, very light, on account of the flatness of the country; yet light grades are even preferred in some instances to obtain a greater bulk of water for flushing. The deposits observed in Berlin seem, however, to be greater than elsewhere. The minimum grades used, are for—

Sewers that can be walked through	1 : 3000
Sewers that can be crawled through	1 : 1800
Pipe sewers	1 : 800

Pipe sewers frequently have a drop in the man-holes.

3. *Junctions, connections, overflows, outfalls.*

The junctions of large sewers are generally made at right angles, except where streets join at acute angles. They are usually in rectangular chambers, with a cylindrical arch, and in a few of which there is a tongue. Funnel arches are avoided. When curves are made to enter the chamber, they mostly have a very short radius. No allowance is made for loss of head in the curves. House connec-

tions are made at an angle, and are inserted where necessary when sewers are built. Overflows, of which there are a great number besides those at the pumping stations, are arranged so that they can be adjusted, with regard to the height of water in the river, by iron bars of square section, (2 inches by 2 inches,) which are placed loosely on each other across the opening and form a dam, which, therefore, can be raised and lowered any distance at pleasure. These dams are used to prevent the ingress of river-water during its high stages. The overflows at the pumping stations have acted fourteen times in a year, with an average duration of 2 hours and 20 minutes each time. There are two ultimate outfalls for the sewage, one on the Osdorf farm, the other at the Falkenberg farm. At present much of the sewage still flows into the Spree.

4. *Ventilation.*

The ventilation of sewers is achieved by perforated manhole covers in the middle of the street, by the street gully inlets and by the soil pipes of the houses. No objectionable odor has been noticed to arise into the street, and the air in the sewers themselves has but a slight smell. The odor at the pumping stations, which are located at various points within the town, is remarkably slight when at all noticeable.

5. *Man and lamp holes, flushing shafts.*

The man-holes are generally situated directly over the sewer and are covered by a circular cast-iron grating, open near the periphery and containing blocks of wood in the middle for deadening noise. One inch or two below the cover is a sheet-iron plate to catch street dirt, with holes for ventilation in the middle. The man-holes are descended by cast-iron steps set into the wall. For brick sewers the upper diameter is 21 inches, and retaining this width in thedirection of the sewer, they increase in width across the sewer and generally rest on the side walls. For pipe sewers the man-holes increase in diameter from 21 inches to 3 feet 1 inch at 4 feet below the surface, which latter diameter they maintain to the bottom. For pipe sewers the bottoms are flat and a few inches lower than the outlet pipe, the inlet pipes being usually higher than the outlet. There are no special lamp-holes and flushing shafts. Man-holes are placed at all street crossings and changes of directions; otherwise they are from 200 to 300 feet apart.

6. *Gullies.*

The gullies have a horizontal inlet in the gutters, the grating being 15¾ inches by 19¾ inches. They have a catch-basin 26 inches square and 34 inches deep below the outlet. The entire depth of the gully is 7 feet 4 inches below the gutter. The outlet is rectangular, 4 inches high and 8 inches wide through the wall of the basin, then it is circular, 6¼ inches in diameter to the sewer. The trap, or rather screen, as it is perforated with two holes at the top, each an inch in diameter, is a sheet-iron flap, hinged above the outlet so that it can be raised in case of obstructions. It stands 2¼ inches from the wall, but is bent to fit closely against it with its sides. It is mainly for the purpose of preventing floating matter from getting into the sewer. Gullies are never placed at intersections or near crossings, but in the block.

7. *Pumping-stations.*

There is to be a pumping-station for each radial system. It is intended to pump, besides all sewage, an amount of rain-water of equal quantity. The following notes refer to system III, as it is the only one entirely finished. The rest will be in similar proportions. The station contains buildings for engines, boilers, coal, employés, &c., a well for water of condensation, a large circular catch-basin, with screen and an overflow to river. There are 6 engines (Woolf's horizontal), 2 coupled to one fly-wheel, with a total of 360 horse-power, driving 6 pumps, with a capacity of 1,000 cubic feet per minute. Only three of the pumps are ordinarily in use, the other three being kept for rainy weather. In 1878 4,839,400 cubic meters were pumped to Osdorf, requiring 25,500 hectoliters coal at a cost of 33,500 marks (1,278,280,000 gallons, with 3,330 cubic yards coal, costing $8,400). All of the pumps south of the river amount to 500 horse-power. The stations are very neat, located in the city, and are without any noticeable odor. The lift to the southern farm, Osdorf, is 75 feet; to the northern farm, Falkenberg, 105 feet.

8. *Miscellaneous.*

For crossing the canals there are four pipe bridges and one inverted syphon.

9. *Materials and construction.*

Materials used for sewers are pressed brick and terra-cotta pipe. The ordinary sewers are all pipe; the main collectors are brick. The subsoil being very sandy, and sometimes peat and bog, there were great difficulties to encounter, as many sewers were built below subsoil water, which should of course not be pumped. A water-tight cradle was usually built into the trench by means of concrete, molded under the water and reaching up to its surface. After hardening, the trench was pumped dry. The sandy soil above the water required sheet-piling in most places. The invert of brick sewers was generally made either of terra-cotta blocks or lately of blocks formed of bricks, about a yard long and 18 inches wide, which were lowered into the trench. A course of smooth stretchers was laid on top of the blocks in both cases. The brickwork is made water-tight with the greatest care, because all of the ordinary flow of sewage must be pumped. Wedge-shaped bricks are used for arches, of four patterns for diameters from 1 meter to 2 meters. Bricks molded to circular curves, both headers and stretchers, are used for man-holes. Size of ordinary bricks is 9⅞ inches by 4⅝ inches by 2⅝ inches. Pipe sewers are also laid with greatest care, from the lowest point upwards. To control an accurate gradient and alignment a lamp is kept burning at the starting point, which by reflection shows any irregularity and enables the pipe to be thoroughly cleaned. The pipes are jointed with gasket and puddled blue clay on the outside, and cement from the inside if the pipe is large enough. This jointing has given perfect satisfaction. One mason and four helpers can lay 70 feet a day of the larger and 100 feet of the smaller sewers. The mortar is mixed of German Portland (Stettin) in proportion of 1:3 of sharp sand. Concrete is made of 1 part cement, 3 of sand, 5 of stone. The joints are small and carefully struck so that the inner surface is very smooth. The hinged flap in the gullies is of sheet-iron, the outlet pipe through the brickwork including the downward turn is made of cast-iron. The gullies and man-holes are usually built on a large flag-stone as a foundation. The foundations for sewers are usually concrete, from 1 foot to 2 feet 6 inches deep. The execution of the work is entirely by day's labor, under the direction and inspection of the city officers, except the excavation and sheet piling, which are done by contract. All materials are obtained from the best makers, not necessarily from the lowest bidders.

10. *Statistics.*

Radial system.	Area, acres.	Inhabitants, about—	Houses.	Inhabitants per house.	Inhabitants per acre.
I	670	103,000	1,190	87	152
II	862	167,000	2,860	58	192
III	964	107,000	2,860	37	110
IV	2,130	244,000	4,080	60	113
V	1,819	194,000	2,830	69	106
VI	1,001	46,000	720	64	46
VII	642	36,000	770	47	55
VIII	1,413	20,000	300	67	14
IX	1,258	11,000	240	46	9
X	971	35,000	550	64	36
XI	828	6,000	110	55	7
XII	430	8,000	120	67	18

Length of sewers finished December, 1880:

	Miles.
Pipe	113
Brick	13

Dwellings (not houses) connected, 30,000.
Length of brick sewers built daily in season, about 450 feet.
Distance from pumps to southern sewage farm, 8 miles.
Lift of pumps, 70 feet.
Sewage reaches farm from extreme dwellings in 5 hours.
Greatest calculated dilution of sewage at the moment when overflows begin to act, 1 to 8.186.
Greatest dilution when sewers are running full, 1 to 153.2.

Statistics of Radial System III (finished).

	Yards.
Length of brick sewers 3 feet to 6 feet 6 inches high	10,267
Length of pipe sewers	73,861
Length of storm-water overflows (brick)	1,969
Length of storm-water overflows (pipe)	656
Number of gullies	1,450
Number of man-holes	1,060
Number of storm-water overflow sewers	5
Number of short overflows	30
Water consumption per head ... gallons	33½
Houses (not dwellings) connected	2,445
Average number of dwellings to 1 house	8.7

Sewers are built for a density of population of 800 per hectare, or 320 per acre.

Statistics for other systems, in 1880.

Length of brick sewers finished	yards	56,869
Length of pipe sewers finished	yards	53,730
Length of storm-water sewers finished	yards	5,877
Number of houses connected		1,200

III. IN HOUSES.

Sewer connections are obligatory, since 1874, as soon as sewer is laid in front of property. All excrements, waste and rain water must be led into sewer. Cess-pools are prohibited. Owners must submit a plan of a complete house-drainage for examination, and it must be executed within six weeks after approval. The execution is subject

to inspection. The city lays the house-pipes to the inside of the front wall, and the rest is done by the owner. Where sewers can not yet be built, the cask system is obligatory in the mean time. The use of the public water supply is obligatory wherever there are pipes in the street. All old works, including cess-pools which have been superseded by the new ones must be removed within thirty days notice. Soil-pipes 4 inches in diameter must be carried beyond roof or into chimneys. Every inlet is to have a fixed strainer. Below every inlet there must be a water-trap. The outlet from water-closet (neck) shall not be over 2¾ inches in diameter. Water-closets must have ample flushing arrangements. The main house-drain (maximum 6 inches in diameter) after entering the house is to be provided with a valve to prevent back flow from the sewer, with a removable lid.

Condensation water is only allowed to enter sewers on special permission, exhaust steam never. After house drainage is completed, the old gutters are filled, and granite curbs, 12 inches broad and 10 inches deep, set on concrete, are built in their place. Sink-pipes must have a diameter not greater than 2 inches. Privies in the yards are to have a hopper closet with a trap below frost. Rain-water from the yards must be led into gullies also trapped below frost, and not run into the street over the side-walk. The portion of the main pipe leading through the wall and into the house is of cast iron and asphalted—the soil-pipe likewise, and both have leaded joints. Exceptionally, vitrified pipes are permitted under the cellars. Cellars must be 1 foot above the highest subsoil-water level.

Yard gullies are built of brick, well cemented, 15 inches square and 5 feet deep, and the outlet must be 3 feet 4 inches below surface. It must be trapped. Grease traps are to be inserted wherever necessary. They are to be of cast iron, enameled, 10 inches by 14 inches, and at least 14 inches deep. The minimum fall for house-pipes is 1.25 per 100; the maximum for horizontal pipes is 3 per 100. The tax for house connections is not a fixed one, but proportional to the supposed advantages gained, and is adjusted every year according to the amount of money required to extend the works. In 1879 it was about $45 per building in the districts where works were being executed.

IV. DISPOSAL OF SEWAGE.

All of the sewage is to be pumped and distributed over two farms for irrigation and filtration, one to the northeast, for the part of the city north of the Spree; the other to the south, for the southern portion. The former is at Falkenberg, 6 miles from the center of Berlin, with an elevation of 102 feet above the Spree, and an area of 1,830 acres; the latter is at Osdorf, 9 miles from the center of Berlin, with an elevation of 72 feet above the Spree, and an area of 2,050 acres. The level portions are used for filtration and winter storage, the gently sloping areas for the furrow system, and greater slopes for broad irrigation. A novel feature are the winter basins into which the sewage is turned, after vegetation ceases, to a depth of 2 feet, and allowed to soak away. The odor from them is very great, but no houses are within a mile. In the spring the ground is plowed, and summer grain of excellent quality grown upon it. The entire farm is to be sub-drained. The effluent is satisfactory. The soil consists of a loamy and almost pure sand, and its fertility before sewage is turned upon it is very poor. Now, crops are raised better than the average quality of the ordinary farm. The Falkenberg farm is not yet prepared. Osdorf receives the sewage from Radial Systems I, II, and III through two mains 1 meter in diameter each. The farm is divided into fields, meadows, vegetable gardens, and winter basins which are fields in summer. The gardens are leveled and every meter have a furrow into which the sewage is turned. The sewage is delivered at the two highest points into stand-pipes, its height being indicated by means of a float and flag. From these points pipes are laid in various directions along the ridges, from which the sewage is turned into open carriers 20 inches deep, and led to the different fields. About 1,000 acres are at present prepared and operated. About 0.27 gallon per second per acre is delivered to the farm. The temperature of sewage arriving at farm is seldom less than 41° Fahr.

	Temperature of—		Minimum temperature of air during month.
	Sewage at farm.	Air.	
December, 1870	+40.5	+25.5	+1.40
January, 1871	+36.1	+23.0	—5.35
February, 1871	+35.4	+29.8	—4.45

The city owns and operates the farms. Irrigation was begun systematically in 1873.

D.—Maintenance of Sewerage Works.

1. *Appliances.*

Pen-stocks are not used. The pipe sewers are flushed by having wooden plugs inserted and drawn when sufficient water has accumulated, or by using flaps for the same purpose. The cleaning gangs take with them in a small wagon, a bundle of iron rods 8 feet long and ½ inch diameter to insert into the pipes, buckets, a tripod, two pieces of hose to attach to water plugs, a water meter to measure the quantity used, lanterns, scrapers of wood, and cylindrical brushes with sufficient quantity of tarred rope to draw them through the pipes. The large brick sewers are cleaned by hand with scrapers and shovels.

2. *Method.*

About every two weeks all pipe sewers are flushed, generally with hydrant water. For this purpose the ends of the pipes in a man-hole are closed either by flaps or plugs, the man-hole itself is filled with water by a hose attached to the nearest fire-plug, and the flap of the lower pipe is raised, which allows the water to rush through it with an initial head of 6 to 10 feet. Beginning at the highest point the silt is flushed from section to section until it is discharged into the brick sewers, where the greater quantity of water and the average velocity of 1 foot 8 inches generally removes most of the sediment, and if not, it is swept or pulled by scrapers to a convenient man-hole and there lifted out in buckets. The brick sewers are inspected, walked through, and cleaned once in 3 weeks. The large catch-pit at the lower end of each system (pumping station) is cleaned weekly. The sand removed is black and has a very trifling odor. When the flushing of pipe sewers is not sufficient, cylindrical brushes are drawn through them simultaneously with the flushing. From Radial System III about 600 cubic yards of silt were removed, or less than a pint a day for each house, including street silt. On account of the light grades a good deal of silt is therefore deposited. There has been no stoppage as yet necessitating the taking up of any section, although the system has been in operation for four years. To clean the sewers of System III there are three gangs, each consisting of 1 foreman with 3 men, to whom is allotted a section of about 800 houses and 17 miles. The cleaning in the principal streets is done at night. One gang cleans about 660 feet of pipe in one night, and removes ½ to 2 cubic yards of silt. At the pumping station there is daily removed from the screen about one wheel-barrow full of paper, rags, sticks, &c., which is burnt in the furnaces.

In 1878 there were pumped from System III to the farm 3,505,150 gallons; in 1879, 3,716,604 gallons. In the latter year this quantity has been estimated to consist of 9.1 per cent. rain-water, 1.6 per cent. of water used for flushing, the rest of sewage proper, being 1,358 gallons per house and 32 gallons per head daily. Storm-water overflows acted 14 times in the same year, averaging 2 hours and 20 minutes in duration.

E.—Cost of Sewerage Works.

1. *Management and maintenance.*

General office:

	Marks.
Director and 6 persons	18,472
Office, &c.	8,028
	26,500
or,	$6,630

Radial System I (not finished):

	Marks.
Pumping, 10 persons	12,540
Coal (16,750 marks) and miscellaneous	24,845
Cleaning, 2 inspectors and 6 laborers	10,064
Clothing, materials, tools and carting	8,151
Repairs	500
	55,700
	$13,925

Radial System II (not finished):

	Marks.
Pumping, 10 persons	12,540
Coal (18,875 marks) and miscellaneous	28,125
Cleaning, 3 inspectors and 7 laborers	12,902
Clothing, materials, tools, and carting	10,152
Repairs	100
	63,819
	$15,955

Radial System III (finished):

a. Pumping station.

	Marks.	
1 engineer, dwelling provided	2,100	$525
5 machinists, dwelling provided for 3	7,380	1,845
5 stokers, dwelling provided for 1	3,360	840
2 laborers, cleaning engines and building	1,800	450
1 laborer, for grounds and miscellaneous	630	158
1 gatekeeper	1,080	270
For intermediate pumping station:		
1 engineer	1,620	405
1 machinist	1,440	360

	Marks.	
1 stoker and laborer	900	$225
Total	20,310	5,078
Materials:		
2,645 cubic meters coal at 12.50 marks	33,062	8,265
Oil, packing, and cleaning materials	6,690	1,673
Brooms, rope, and sundries	192	48
Clothing and boots	266	66
Carriage hire	108	27
Water tax	1,050	263
Gas	3,500	875
State tax	1,405	351
Repairs to engine and buildings	2,999	750
	49,272	12,318

b. Maintenance of sewers.

1 inspector, dwelling provided	3,000	750
3 foremen, at 4.50 marks per day	4,927	1,232
9 laborers, at 3 marks per day	9,855	2,464
Extra labor	1,826	457
Night watchman, at 1.50 marks per day	548	137
	20,156	50,40
Materials:		
Clothing, boots, and grease	1,120	280
95,000 cubic meters of water for flushing at 15 and 10 pfennigs per meter	12,967	3,242
450 loads of silt removed, at 4 marks	1,800	450
Hose, &c	955	239
Repairs, alterations	7,351	1,838
	24,193	6,049

Radial System IV (not finished):

Pumping, 10 persons engaged	12,850	3,212
Coal (21,375 marks) and miscellaneous	31,125	7,781
Cleaning, 3 inspectors and 7 laborers	13,002	3,251
Clothing, tools, materials, and carting	11,083	2,771
Repairs	100	25
	68,160	17,040

Maintenance and improvements of sewage farm at Osdorf. (Radial Systems I, II, III):

	Marks.	
1 inspector	1,600	$400
1 assistant inspector	1,000	250
27 sewage distributers, at 910 marks	24,570	6,142
13 assistant sewage distributers, at 600 marks	7,800	1,950
Farming, inspection, labor, and materials	97,400	24,350
Insurance, school, police, and taxes	7,316	1,829
Repairs and alterations to farm and tools	13,000	3,250
House expenses	2,000	500
Cattle and food	72,000	18,000
Seeds and planting trees	19,250	4,812
Miscellaneous	1,534	383
	247,470	61,866

Maintenance and improvements of sewage farm at Falkenberg. (Radial Systems IV and V, not completed):

	Marks.	
Total expenses	5,650	$1,410

Receipts from Osdorf farm:

Sale of produce	168,390	$42,098
Sale of stock, milk, manure	78,440	19,610
Miscellaneous	660	165
	247,490	61,873

Miscellaneous:

For Radial System III there were pumped in 1878, per house (not dwelling), 528,300 gallons, with 1.4 cubic yards of coal for $3.33. Price of coal, $2.38 per cubic yard.

Tax for water used for flushing, 28.4 cents per 1,000 gallons.

Funds for building the new works are raised by a general loan at 4 per cent., with 1 per cent. sinking fund. In addition there is an assessment on properties, being a tax of 1 per cent. of the increased valuation of each property due to the construction of the sewerage works.

2. *Construction.*

Total cost of radial systems up to 1880:

I, Rad. system nearly finished	$1,225,000
II, " " nearly finished	1,575,000
III, Rad. system finished	$1,526,000
IV, " " nearly finished	2,400,000
V, " " nearly finished	2,156,250

Cost of materials:

1,000 bricks cost $7 to $10; cement is worth $2.25 per 400 pounds; iron pipe, 2 cents a pound; puddled clay, ready for use to join pipes, $6 to $8 per cubic yard; traps for house connections, $4.50, including laying; 1 square yard of sheet-piling in place costs $1.75.

Cost of labor:

Laborers, 5½ cents per hour.

Mechanics, 8½ cents per hour.

Excavation costs 30 cents a cubic yard above, and 60 cents below subsoil-water, including pumping.

Brick sewers, 3 feet 3 inches by 2 feet 6 inches, cost $5.40 per running foot.

Pipe sewers, 20 inches diameter, cost $3.08 per running foot.

Branch pipes to houses are laid at owner's expense.

Cost of ground for Osdorf farm, per acre	$166
Cost of preparing ground, per acre	62
Cost of carriers, per acre	62
Cost of subdrainage, per acre	45
Total, per acre	335

Total cost of farm (2,050 acres), $686,750.

VIENNA.

A.—Statistics of Locality.

1. *Population.*

City proper	730,000
Contributing to sewers, over	1,000,000

2. *Area.*

City proper (4,200 hectares)	acres..	10,379
Sewerage area (6,300 hectares)	do...	15,568

3. *Dwellings.*

Number of houses	12,274
Number of dwellings	143,617

4. *Water Supply.*

Maximum daily amount that can be delivered	gallons..	29,847,933
Daily summer consumption	do....	16,441,985
Daily winter consumption	do....	12,705,182

Obtained from mountain creeks in covered aqueducts, by gravity. Average for domestic purposes per head per day, 16 gallons.

5. *Mortality.*

Varies from	28.2 to 38.7
Mean for several years	30.6

6. *Meteorological.*

	Fahrenheit.
Temperature, mean annual	49.46
Highest temperature	101.84
Lowest temperature	—13.90
Mean maximum temperature, annual	93.02
Mean minimum temperature, annual	4.82
Mean temperature, summer months	67.10
Mean temperature, winter months	31.00
Mean yearly range of temperature	94.10

Mean yearly rainfall, 22½ inches.

Maximum yearly rainfall, 31 inches.

Average yearly number of rainy days, 144.1.

Penetration of frost, 27 inches; maximum, 32 inches.

Maximum rainfalls:

	Inches per minute.
1853. June 23: 22.4 millimeters in less than 60 minutes	0.0150
1854. July 19: 21.4 millimeters in less than 60 minutes	0.0140
1860. May 2: 48.9 millimeters in 110 minutes	0.0175
1870. July 18: 40.6 millimeters in 140 minutes	0.0114

7. *Topographical.*

Situate on the right bank of the Danube, which flows in a southerly direction. The city is intersected by the Donau Canal, a branch of the river, leaving it above and reuniting with it below the city, and a small river called the Wien, discharging into the "Canal." The surface between the latter and the Danube is almost a level, and is 13 to 18 feet above low-water. The rest of the city is on a gradually sloping and undulating ground, closed in by hills. The highest point in the city is 223 feet at low-water. Low-water is 497 feet above the sea.

Several creeks issuing from the near hills formerly passed through the town, but are now converted into sewers.

Length of Donau Canal is 10.4 miles; its width at low-water is 140 to 180 feet; its discharge at low-water is 3,709 cubic feet per second; at high-water, 22,428 cubic feet per second.

8. *Physical.*

The flat territory between the canal and the river is mostly open; a small district near the former is built up. In the northwest, the ground is as yet unimproved or covered with scattered buildings. In the southwest, the territory is converted into a park (Prater). The greatest part of the city lies to the west of the canal; the older portion is closely built up, and has quite narrow streets. This part is surrounded by a belt—the old line of fortifications—1,000 to 1,500 feet wide, called the "Ring," which now is a comparatively open space, containing promenades and the main government and other buildings. Outside of the "Ring" the territory is again closely built up in all directions to the limits of the town. The pavements are granite blocks, and recently have been replaced by asphalt to some extent. In open territory they are macadam.

B.—Management of Public Works.

All public works are under a "general director." The separate departments are as follows:

I. Architecture, for public buildings and grounds.
II. Water supply.
III. Rivers, canals and sewerage; headed by a chief engineer, with a staff of two principal assistants, one for each half of the city, eight assistants for general design and maintenance, and a large staff of clerks and inspectors.
IV. Streets and bridges, and
V. Fire department.

The yearly budget is about $8,000,000. New works, as well as the maintenance of existing works, are done by contract.

C.—Design and Construction of Sewerage Works.

I. General System and Alignment.

Combined water-carriage, with some dry removal, which is gradually being abandoned. System is not satisfactory on account of many old and improperly designed works. New works are gradually replacing and supplementing them. Since 1859 the question has received systematic treatment. All sewage discharges into the Donau Canal. At present there is a project to build an intercepting sewer along its entire eastern bank, discharging into the Danube several miles below the city. The Wien River is preserved from contamination by an intercepting sewer on each shore; a third one protects the extensive flat ground in the south from the storm-water of the adjoining high grounds. The rest of the sewers are along the valley lines, several of them inclosing creeks originating in adjacent mountains.

II. In Streets, etc.

1. *Shape and size of sewers.*

Pipe sewers are not used, but will shortly be introduced for house branches only. The shape of the sewers is oval, the invert is rather flat with a radius but a little less than that of the arch. The older sewers, especially those carrying creeks, are of various shapes, generally with a level bottom and semicircular arch. The *débris* is less likely to block up a flat bottom than a semicircular one. The sewers are all sufficiently large to be entered, which requirement determines their minimum size. The capacity is calculated according to Darcy and Bazin's formula, in the following form:

$$\text{Mean velocity per second} = \sqrt{\frac{\dfrac{\text{sect. area}}{\text{perimeter}} \times \text{sine of slope}}{A + B\dfrac{\text{perimeter}}{\text{sect. area}}}}$$

$A = .00019$; $B = .00013$.

Formerly Eytelwein's formula was used. The maximum rainfall calculated to be provided for is over 1 inch per hour, supposing $\frac{3}{8}$ of an inch to get into the sewers, and to fill them only to the spring. The sizes are divided into types, with the dimensions as follows, in meters:

Type.	Height at key.	Width at spring.	Invert radius.
I	1.10	0.80	0.338
II	1.26	0.84	0.35
III	1.35	0.90	0.367
IV	1.50	1.00	0.42
V	1.65	1.10	0.45
VI	1.80	1.20	0.50

For house branches the size ordinarily used is:

VII	1.05	0.60	0.22

Larger sewers, with spans to 20 feet, with flat bottoms, are used for carrying old creeks.

2. *Depth and grade of sewers.*

The depth of sewers below the pavement varies in general from 10 feet to 15 feet.

The grades, on account of the undulating surface, are as a rule very good. The maximum grade is 0.027 (1:37). The minimum grade is 0.0016 (1:608). The grade for the intercepting sewers is 0.0022 (1:455). The common grades for ordinary sewers are about 1:100.

3. *Junctions, connections, overflows, outfalls.*

Junctions of sewers are usually built at 45°, or are tangential, with comparatively small radius. Sewers which are too large ever to get filled join the others at 70 to 90°.

The house branches usually terminate at right angles, as in Paris.

Overflows are built at various places in the two intercepting sewers along the Wien River.

For the proposed main interceptor along the Donau Canal, overflows will be put opposite every valley-line sewer discharging into it.

All the present outfalls are along the Donau Canal at different elevations, varying from mean to ordinary high water. They are unsightly and obnoxious.

4. *Ventilation.*

Ventilation is had by open grates in the man-holes and partially through soil and rainwater pipes of houses.

Odor in the old sewers, particularly those built of rough masonry, is very strong at all times. The odor in the new brick sewers, and especially in the concrete sewers, is on the other hand very slight.

5. *Man and lamp holes, flushing shafts.*

Man-holes are usually 2 feet square in section, 63 × 63 centimeters increasing in size towards the bottom, if very deep. They are placed at intervals of about 200 feet apart and are all ventilating. Usually they are built directly over the sewers, but in very frequented streets they have side entrances from the side-walks. The grating has holes 2 inches square by 3 inches to 4 inches deep, with one-half inch of metal between. The iron stepping-rods are placed across the corners. There are no lamp-holes nor flushing shafts in use.

6. *Gullies.*

The gullies vary in design with the inlet. They are sometimes vertical, in the curb (Paris), with an opening 4 inches by 12 inches, and sometimes horizontal, in the gutters, and covered with a grating. The latter is usually square in plan, measuring from 12½ inches to 18¼ inches. Many gullies are supplied with catch-basins, especially in the suburbs, and they are rarely trapped. The connection with the sewer is by a branch, 3 to 4 feet high, having a good slope and a rectangular junction with the larger sewer.

The gullies are placed in the block, not at street corners. The curbs are 12 inches to 14 inches broad, and their height above the gutter is generally 3 inches to 4 inches.

7. *Pumping-stations.*

No sewage is pumped.

8. *Miscellaneous.*

* * * * * * *

9. *Materials and construction.*

Sewers are built of bricks and concrete. Pipes are also to be used in future.

Bricks are of the best and are ordinary and wedge-shaped. In the arches both kinds are used in alternating courses. Dimensions of the Austrian bricks are 11½ by 5½ by 2½ inches. The brick-work is built of concentric rings, between which is a heavy coating of cement to render the work water-tight.

Concrete sewers are built in preference whenever the cost is not too great. The centers are made of planed cast-iron, which gives the sewers a great degree of smoothness. The best Portland cement is used, in the proportion of 1 to 2 of sand and 5 of stone. Cement is carefully test the for every work.

10. *Statistics.*

	Yards.
Length of main sewers	59,308
Length of ordinary sewers	191,933
Length of house branches	429,800
	681,041

Or, 387 miles.

III. IN HOUSES.

Cess-pools are being abolished and water-closets introduced.

House branches (passage-ways, as in Paris) are built from the sewer to the house. They are 6 feet to 3 feet 3 inches high and 2 feet wide. The excrements and the house-water are turned into them, but on account of the slight fall they deposit and must be drawn into the sewer with a scraping tool. It is urged at present to substitute vitrified pipes for house branches.

Up to 1867 they were cleaned at the owner's expense; since, they are cleaned by the city. The length of these brick pas- sage-ways is 245.4 miles.

Number of cess-pools still remaining	836
Number of buildings connected with sewers	10,100

IV. DISPOSAL OF SEWAGE.

The solid matter that is taken from the house branches and sewers, also the contents of cess-pools, are filled into barrels and carted to the "canal," where they are placed on lighters and towed to its junction with the Danube and there discharged into the current.

Sometimes small quantities are sold for a trifle, as manure.

The sewage discharges into the canal.

At low water its pollution is estimated at one part sewage to 3,500 parts river-water, ordinarily it is one part sewage to 5,800 parts river-water. Interception and discharge into Danube is contemplated.

D.—MAINTENANCE OF SEWERAGE WORKS.

1. *Appliances.*

The contents of cess-pools and the cleanings from the sewers are removed in casks of wood, strongly built and provided with tightly fitting covers. These are again removed on boats or scows specially constructed for the purpose. Both casks and boats belong to the city. Besides, ordinary scraping and loading tools are used for cleaning the sewers.

2. *Method.*

The house-passages or drains are cleaned by the city, as well as the sewers, the whole of which is done under one contract. The inspection is very thorough. The cleaning is done at certain fixed periods. House-passages are scraped out once a month, cess-pools are emptied when they are three-quarters full. Sewers are cleaned at intervals varying with their grade. Those with a fall of less than five feet per 1,000 are cleaned once a month, those with 5 to 10 feet per 1,000 every two months, all over 10 feet per 1,000 every three months. When deposits reach a greater depth than 3 inches, a special cleaning at intermediate times is required.

Besides this regular cleaning, special cleaning may be done on private complaints. The inspectors must walk through the sewers of their districts and examine them after each cleaning and report condition Full records are kept of this work both for sewers and houses.

The cleaning is done at night between ten and five o'clock, in winter to six o'clock, and its extent is daily reported.

All filth, rubbish, &c., is loaded into casks and carted to the canal where it is placed upon boats, towed to the Danube, and there discharged. In the winter it is carted to the Danube and discharged opposite the city. The casks must be quite filled and the empty ones returned in a clean condition. The cess-pools are emptied by pumping the contents into casks. After the cleaning of house-passages, they are slightly flushed with water. Sewers have no flushing arrangements, such as pen-stocks, movable dams, &c., although they are contemplated for the future. The contractors for maintaining the sewers have also to free the outfalls in the Wien River or canal from objectionable accumulations.

Payments for cleaning are made in a gross sum for the year with proportionate increase or decrease for new or abandoned sewers or drains.

In 1879 there was a length of 820 miles of sewers cleaned.

E.—COST OF SEWERAGE WORKS.

1. *Management and maintenance.*

Annual cost of cleaning sewers	$42,475
Annual cost of cleaning house-drains and cess-pools	63,700
Annual cost of repairing sewers (owing to many being old and dilapidated)	20,000
	126,175

The payments for new sewers are divided, so that property-owners bear one-third, *i. e.*, one-sixth on each side of street, and the city two-thirds of the expense.

The payments for cleaning house-drains, passages, and cess-pools are made by city, but the amount is reimbursed by owners in proportion to assessed value of property.

2. *Construction.*

Cost of sewers up to 1880, about	$4,600,000

LIVERPOOL.

A.—STATISTICS OF LOCALITY.

1. *Population.*

City proper	550,000
Water supply and drainage district	680,000
Average density per acre	102.2

2. *Area.*

City proper ... acres	5,211
Water supply and drainage district, about ... do	6,800

3. *Dwellings, &c.*

Number of houses in city, about	90,000
Inhabitants per house	6.2

4. *Water supply.*

From small rivers, creeks, and a few wells, averages 17,750,000 gallons per day, or 32.3 gallons per head.

5. *Mortality.*

Mean for twelve years	28.5
In 1879	27.0

6. *Meteorological.*

	Fahrenheit.
Temperature, mean (1878)	48.5
Maximum (1878)	85.0
Minimum (1878)	12.7
Mean of daily maximum (1878)	54.4
Mean of daily minimum (1878)	44.6
Rain, 189 days (1878) ... inches	28.93
Mean humidity (1878)	84.00

Greatest observed rainfall, .75 inches per hour, or 0.013 inches per minute.

Frost, mean, 18 inches; maximum, 24 inches.

7. *Topographical.*

Situate on right or east bank of river Mersey, a few miles from its mouth. The site is upon undulating ground, which rises rapidly towards the east and northeast, reaching elevations of 175 feet in the northern and 248 in the southern part.

The entire river front is taken up with extensive docks. City datum is 5 feet below mean tide.

Tides in Mersey:

Extraordinary high tide, + 25 feet.
Average high water, equinoctial spring tides + 21 feet 1 inch.
Mean high water, + 15 feet 6 inches.
Mean tide-level, + 5 feet 0 inches.
Mean low water, — 5 feet 6 inches.
Average low water, equinoctial spring tides, — 10 feet 4 inches.

8. *Physical.*

The central and eastern parts are closely built up, also those along the river.

The southeastern parts contain the parks and much garden area.

The streets have granite and trap-block pavements of excellent quality, and a small quantity of wood pavements.

9. *Geological.*

The city is located on red sandstone, which generally rises to within a few feet of the surface. At places it is covered with loam and gravel.

Excavation for sewers is usually in rock, but this is generally soft enough to be picked or wedged off.

B.—MANAGEMENT OF PUBLIC WORKS.

The city engineer is in charge of sewers, streets, including tramways, and the registration of property. He is assisted by 15 engineers and 25 clerks. There is 1 chief inspector and 5 district inspectors, each with several foremen, for maintenance and inspection of sewers and house-drains.

The water supply is under a special department, with chief engineer and corps.

C.—DESIGN AND CONSTRUCTION OF SEWERAGE WORKS.

I. GENERAL SYSTEM AND ALIGNMENT.

Combined water carriage with discharge directly into river. The alignment of the main sewers is a combination of interception and valley-line drainage. There are nine outlets into the river along a front of 5 miles. Two sewers, one discharging at each of the extreme

ends of the city, nearly follow the municipal boundary until they almost meet, after encircling the town, at an elevation of 200 feet. They are intercepting sewers for the greater part of their length. The water from the rapidly-sloping ground in the northern part of the town has also been intercepted by three mains, to prevent its accumulation and flooding the flatter districts, but lower down they are valley-line sewers. The extensive series of connected docks fronting the city has also made interception advisable along the wharfs to a great extent, and with but few outlets. The remaining sewers act as natural valley sewers.

The system of alignment pursued with regard to the house is the so-called "back drainage," by which the sewers are led through the back alleys instead of the front streets, and thus not necessitating the house-pipes to pass through or under the cellars, except in rare cases.

The lowest portions of the sewers are regularly filled with back-water, on account of the great tidal range, but they have a good grade and discharge completely above low tide.

II. IN STREETS, ETC.

1. *Shape and size of sewers.*

All sewers are egg-shaped, except a few outfalls, which are circular. Pipes (9 inches and 12 inches diameter) are rarely used, except in the back passages and for house connections.

The sizes of sewers are calculated according to Eytelwein's formula, when necessary, but as the outlets are all constructed, it is preferred to use judgment and proportion according to sewers already built. The least and ordinary sizes are 3 feet by 2 feet or 1 foot 10 inches. The invert is formed by a 6-inch radius. The largest sewers are 6 feet by 4 feet, save a few in the dock estate, which are 7 feet by 6 feet.

2. *Depth and grades.*

The depth of sewers in the street is from 13 feet to 14 feet; in back passages from 8 feet to 12 feet.

The grades of the sewers, owing to the topography, are rather heavy, ranging ordinarily from 6 inches to 2 feet and even 3 feet per hundred.

3. *Junctions, connections, overflows, and outfalls.*

Junctions of large sewers are usually made in a chamber covered by a funnel-shaped arch. Pipe-sewers are joined in man-holes. When pipe-sewers from back streets or houses join a brick sewer, they are brought in at 45°, either by a slant pipe or a block.

The connecting pieces are built into the sewer opposite every house and back street; if not directly used they are temporarily closed by a plate cut out of slate.

There are no overflows, as most of the sewers are along the valley lines, or are sufficiently large to take all of the rain-water.

The outfalls into the river, of which there are 9, discharge from the end of piers directly into the Mersey at different elevations. Six of them have elevations varying from 8 inches above to 5 feet 4 inches below mean low water; 3 from 10 feet 3 inches to 11 feet 4 inches above mean low water.

4. *Ventilation.*

The ventilation is obtained through man-holes and inspection shafts into the streets, and through soil-pipes carried beyond the roofs.

6. *Man-holes, lamp-holes, and flushing-shafts.*

Man-holes are built every 200 to 400 feet. The shaft is generally rectangular, 2 feet 2 inches across and 1 foot 6 inches with the sewer. The bottom widens out into an arched chamber 5 feet long, 6 feet high in the middle and 2 feet 2 inches wide, which gives room to handle the buckets and shovel the silt. At a junction of a pipe-sewer there is a three-branched man-hole, a second arch extending a few feet in the direction of the pipe-sewer. The man-holes formerly had stone covers, but now heavy iron castings, 2 feet 2 inches by 18 inches clear. The cover is hinged on a wrought-iron bolt; the top is ribbed, the interstices being filled with cement. To one side of the man-hole is a small catch-basin 20 inches by 7 inches section and 24 inches deep. It is covered by a hinged iron ventilating-grate, with 12 openings, about 4 inches by 1½ inches each, and is connected with the man-hole by a 9-inch pipe. Lamp-holes or inspection-shafts are of terra-cotta pipe, 9 inches in diameter, drawn in to 6 inches at the top and closed with a tight-fitting cover. Many of them have a small catch-pit of iron at one side, with an open grate to serve as a ventilator.

Flushing-shafts are put at the end of each back-drainage sewer. They are 3-inch vertical pipes, with attachment for hose. The top finish is a sandstone flag, with cast-iron lid over pipe. At the end of the branch sewers of brick there are larger flushing-shafts, into which 250 cubic feet of water can be discharged from a flushing-cart.

6. *Gullies.*

The inlets are placed in the gutters and are covered by a grating 12 inches by 14 inches, resting on a cast-iron head 8 inches high. The bars of the grating are 4½ inches deep by 1½ inches wide, leaving spaces of 1½ inches. The gullies have both catch-basins and traps. The depth of the basin is 4½ feet below the gutter. The trap is formed by a flag giving a seal of 14 inches. The distance from the flag to the bottom is 14 inches; the outlet pipe is 9 inches in diameter. The gullies are placed at intervals of 200 to 300 feet, and always above street intersections.

7. *Pumping-stations.*

No sewage is pumped.

8. *Miscellaneous.*

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9. *Materials and construction.*

Sewers are built of brick and pipes. Bricks are machine-made, have smooth sides, but very rough beds and ends, which is preferred on account of a better adhesion of the mortar. The joints are made very close and are carefully pointed. All bricks are wedge-shaped to the proper circles; for man-holes both headers and stretchers are formed to fit the circular curve. Parallel bricks measure 9 inches by 4½ inches by 3½ inches.

Blue bricks (Staffordshire) are used on steep grades for the first 5 courses from the bottom on each side. In rock excavations the invert is formed of one 4½-inch ring; in earth two 4½-inch rings are used, with a coat of cement between to prevent leakage into the soil. Arches always have two 4½-inch courses.

Pipe sewers are seldom over 12 inches; never under 6 inches in diameter. The best salt-glazed socket-jointed pipes in 2-foot lengths are used. They are carefully leveled, singly and 5 together.

Mortar is mixed of best Portland cement and sand. The latter is principally crushed soft red sandstone rock, usually found in the trench. The mortar for pipes is mixed in the proportion of 1 to 1; for inside ring of brick sewer, 1 : 3; for outside ring, 1 : 5.

All materials are of the best. Sewers are built by day's work by the department. Occasionally the excavation is done by contract.

10. *Statistics.*

In 1847 there were about 50 miles of sewers.

Length of sewers in 1880:

Main sewers	miles	23
Secondary (branch) sewers	do	200
Pipe sewers near summits and in back passages	do	445
House branches	do	280
Number of gullies		15,840

Estimated daily amount of sewage discharged into Mersey, 16,000,000 gallons.

III. IN HOUSES.

Cess-pools have been abolished and carefully cleaned and filled up. Water carriage is compulsory for all houses.

Plans for the house drainage are subject to the approval and their execution to the inspection of the department.

The system of back drainage is preferred, by which the house pipes run to a back alley into 12-inch pipes, which discharge into the brick sewers on the street.

The main pipe of the house is usually 6 inches in diameter, sometimes 8 inches and 9 inches. Pipes are rarely laid under or through the houses.

Rain-water and soil pipes are carried down outside the house, the first into a disconnecting man-hole, the latter directly into the sewer, and its other end is taken above the eaves. Water-traps are used against the soil-pipe; the disconnecting man-hole is trapped against the sewer.

IV. DISPOSAL OF SEWAGE.

The sewage is discharged outside of the docks into the Mersey at all times. The volume of water passing the city at both tides is too great to make any pollution noticeable.

D.—MAINTENANCE OF SEWERAGE WORKS.

1. *Appliances.*

Sewers are cleaned almost entirely by flushing. Pen-stocks are used for the larger sewers, iron flush-tanks mounted on wheels and holding 250 cubic feet for smaller ones.

Small trucks gauged to run on the inverts and to carry silt-buckets, also small derricks placed on wheels to lift them out are used.

2. *Method.*

Every sewer is flushed at least once in three months. The good grades do not allow much deposit. In a few localities, especially where heavy grades change to light ones, the sewers must be cleaned by hand.

The highest sewers are generally flushed first. The flush-tanks are taken above the man-hole, or shafts, and their contents (250 cubic feet) are discharged through an opening in the bottom in fifteen seconds. Where flushing does not suffice, the silt, which is mostly sand, is thrown into buckets placed on small trucks in the sewer, drawn to the man-hole and lifted out by means of a small transportable derrick. The sewers are in a fair condition. There

is much repairing done to the inverts on heavy grades, and to the older sewers, to give them regular and smooth surfaces.

E.—Cost of Sewerage Works.

1. *Management and maintenance.*

Department expenses for maintaining and repairing sewerage works are about $100,000 annually.

Annual cost of flushing sewers, alone: $20,000.

2. *Construction.*

The average cost of a 3 feet by 2 feet sewer, with 21 feet depth of cutting, is $5 per running foot.

Labor is paid for at $6 per week.

Bricks, ordinary and wedge-shaped, average $7.20 per 1,000.

House-connecting blocks cost $1.70 a piece.

HAMBURG.

A.—Statistics of Locality.

1. *Population.*

Hamburg State		420,000
City proper, including Altona		500,000
Built up and sewered portion of Hamburg alone		373,700
Inhabitants in old city		156,000
Density of population in southeastern section	per acre..	445
Density in other sections decreases to	per acre..	81
Average density for city and suburbs	per acre..	92

2. *Area.*

Hamburg State	acres..	218,643
Built up area of city	acres..	15,074
Area sewered	acres..	18,533

3. *Number of houses.*

Total, about	13,500
In old city	5,220

In old city: average number of dwellings per house, 6.5, and 4.3 persons per dwelling.

4. *Water supply.*

From river Elbe, filtered.

Consumption, maximum	cubic meters..	90,000
Average	cubic meters..	77,730

Daily average, 46 gallons per head.

5. *Mortality.*

Average for 10 years	27.9
1879	26.5

6. *Meteorological.*

	Fahr.
Temperature, yearly mean	47.30
Greatest maximum	92.66
Greatest minimum	—22.00
Mean of maximum, summer months	65.48
Mean of minimum, winter months	6.26
Ordinary yearly maximum	78.80
Ordinary yearly minimum	—4.00
Mean range yearly	83.00

Average yearly rainfall (10 years) 27¾ inches.

Greatest observed rainfall, 21 millimeters in 45 minutes, 0.0184 inches per minute.

Frost penetrates usually 1 meter (40 inches).

Prevailing winds, west.

7. *Topographical.*

Situate on right and north bank of the river Elbe, about 63 miles above its mouth. The city is bisected by a creek, the Alster, which has been transformed into a navigable canal in the central city, and forms two lakes (basins) in the northern part of the city. The western and northwestern section of Hamburg comprise the high districts, (Geest,) reaching elevations of 230 feet; the eastern section is low and to a great extent guarded against high tides by dikes and relieved of subsoil water by wind-pumps.

Backflow of high tide into the Alster is prevented by 2 dams, now streets, across the valley at 12 feet 3 inches above ordinary high water. The level of the Alster basins is kept constant at 5 feet 1 inch above ordinary high water.

Mean discharge of Alster is 160 cubic feet per second.

Minimum discharge of Alster is 70 cubic feet per second.

Ordinary high water of Elbe above datum	+17′ 9″
Ordinary low water	+10′ 9″
Ordinary mean range	6′ 1″
Highest known tide, 1825	+28′ 8″
Lowest known tide	+ 1′

Discharge of northern arm of the Elbe at low water is 3,532 feet per second.

8. *Physical.*

Densely built-up sections, with narrow streets, are situated near the Elbe and eastern part of the town. In the northwest part there are considerable spaces quite open, and used as parks, promenades, zoological garden, &c.

Streets in the newer sections are of moderate widths. Pavements are of granite blocks. The suburbs are open, with much garden area and macadamized roads.

9. *Geological.*

The southern and old part of the city is built on alluvial sands and clay; the western and northern part, in the higher sections, consist of diluvial and tertiary formations cropping out as sand, gravel, clay, and marl; the eastern, low and marshy districts, are formed of heavy deposits of sand and peat.

B.—Management of Public Works.

Public works are under control of a building commission, consisting of 3 members of the Senate and 10 private citizens.

There are three departments: I. River and harbor works; II. City water supply, and III. Architecture and engineering. The latter is divided into two sections: *a.* Architecture, which is under the supervision of a chief architect and director for all public buildings, with 6 architects, 1 registrar, 2 clerks, and attendants.

b. Engineering, for the design, construction, and maintenance of streets, parks, bridges, and sewers, and for surveys. This section is superintended by a chief engineer (who is also chief engineer for the water supply department, II). There are 5 assistant engineers, 1 registrar, 2 clerks, &c., at a central bureau, besides a staff for 4 districts of the city consisting of 4 division engineers, 5 clerks, and 10 inspectors. In addition, there is a survey bureau, with 1 chief surveyor, 1 chief clerk, 11 surveyors, and 2 draughtsmen; also a bookkeeping bureau for engineering section with 1 secretary, 1 bookkeeper, 2 clerks, and 1 messenger. Besides this staff at the offices, there are 72 foremen, flushers, keepers, &c., for maintenance of sewerage works. The latter are generally built by contract.

Water supply is not furnished on streets without sewers.

C.—Design and Construction of Sewerage Works.

I. GENERAL SYSTEM AND ALIGNMENT.

Combined water carriage with discharge into the northern arm of the Elbe. From the irregularity in the topography, the alignment is somewhat complicated. There are four drainage districts. The old city, drained between 1843 and 1860, with direct outlets into the river; the Geest system, more recently built for the areas draining into the Alster basins; the Hammerbrook flats, which are below high-water level and from which the sewage is pumped and discharged through the Geest main sewer, and, finally, the valley which forms the boundary between Hamburg and Altona. The Geest system is intercepting, the Hammerbrook is radial, the rest are valley-line systems. The sewers can nearly all be walked through, pipe-sewers being rarely used, except for house branches.

Dead ends are avoided as much as possible (Lindley principle) by connection with other sewers or stacks. System was designed by Mr. W. Lindley in 1843. Recent works by Mr. A. F. Meyer.

II. IN STREETS, ETC.

1. *Shape and size of sewers.*

Pipes are used only for house drains. Brick sewers are all egg-shaped, except the intercepting sewers, which are circular. The size is calculated according to Eytelwein's formula, the data being a rainfall of 25 millimeters (1 inch) of rain in 24 hours, of which two-thirds is to flow into sewers. This refers mainly to the intercepting sewers. The minimum sizes of the ordinary sewers are large enough to be walked through, while, on the other hand, overflows into the Alster or canals are provided wherever possible. The amount of sewage calculated is 39½ gallons per head per day, one-half to flow off in 9 hours. The sewers are divided into 10 classes, according to size. The largest (Geest main collector) is circular and 10 feet in diameter, the rest range from 8¼ feet by 7 feet to 3 feet by 2 feet.

2. *Depth and grade.*

The depth of the sewers is generally 10 to 16 feet below the pavement. In Altona it averages 10 feet. The minimum grades are 1:3,000, which is the grade of the Geest main sewer for nearly 8 miles. When half full it has a surface velocity of 1 meter per second. The smaller sewers have grades up to 1:100, in some cases even more.

3. *Junctions, connections, overflows, outfalls.*

The junctions of sewers are made with funnel arches and easy curves.

Connections with house drains are made with pipes at the spring, set in at an angle.

Overflows are placed at various points along the Alster basin and the canals.

The outfall sewers into the Elbe are provided with self-closing gates, to prevent flood-waters from backing into them. They act then as reservoirs for the sewage.

In case of prolonged high water in the river the entire sewage can be run into the canals, and thus relieve the sewers.

The outfalls of the Geest main sewer and others are submerged and discharge into the current through timber twin sewers 220 feet and 130 feet long, sunk to a depth of 21 feet below low water.

4. *Ventilation.*

The ventilation is very thorough. The man-holes are ventilating, and between them, 120 to 140 feet apart, are special shafts for ventilation, 12 inches diameter, covered by a square grating. The street inlets are all without traps and the soil and rain-water pipes of the houses also act as ventilators. The odor in the Hamburg sewers is very slight and rarely perceptible at the surface openings.

5. *Man-holes, lamp-holes, flushing-shafts.*

Man-holes are circular, .93 meters (3 feet) diameter, and are placed 350 to 450 feet apart. In frequented streets they always have side entrances with double cover (London). In others the man-holes are directly over the sewer. The cover is an open grating with no basin to catch dirt. There are no lamp-holes nor flushing shafts used.

6. *Gullies.*

They are situated in the gutter having a horizontal grating, 17 inches by 15 inches. The depth of curb at the inlet is 7 inches, at other points it diminishes to 4 inches and 3 inches. There are two different designs, one with a catch-basin, for streets having macadam in the center, the sides only being paved, and one with a circular neck leading from the grating by a vertical curve directly into the sewer, for all streets completely paved. The catch-basin, in the first case, is 17 inches square, it is 4 feet deep below the surface and 16 inches below the outlet, which is a terra-cotta pipe 9 inches diameter leading into the sewer. The more common inlet is the circular neck, 12 inches diameter, built of brick. To fit it properly at the surface the iron box holding the grating is drawn in at the bottom to form a circle also of 12 inches diameter. All inlets are without traps. It is usual to put a man-hole or ventilating-shaft near the gully, so that the circulation in the latter is generally downward, their connection with the sewer being at the spring. Inlets are generally placed 140 feet apart and rarely at street intersections.

7. *Pumping-stations.*

All the sewage from the Hammerbrook lowlands is pumped into the Geest intercepting sewer by two engines of 60 horse-power, each driving one centrifugal pump and raising the sewage 8 feet 10 inches. The works have only recently been finished.

8. *Miscellaneous.*

The sewage crosses the Alster and the canals at various points by inverted siphons of cast and wrought iron, and also one of masonry. They have caused no trouble in any way.

9. *Materials and construction.*

Sewers are all built of bricks of good quality, pipes being used only for house connections. The courses of bricks are concentric rings with a coat of strong mortar between, to make them impervious to water.

The larger sewers, from 5 feet 6 inches to 8 feet 6 inches high, have three courses in the invert, extending above the spring. The Geest main sewer, circular and in tunnel, has four complete rings. The sizes smaller than 5 feet high have two rings. Wedge-shaped bricks are used for the inside ring of the arch and invert. The connection of the inlets with the sewers is made of pipe when they have a catch-basin attached, of a 4-inch ring of brick when leading directly to the sewer.

The submerged sewer-outlets are of timber, securely framed and bolted.

Portland cement is used for mortar, in proportion of 1 : 3 of sand.

All work is done by contract. Sewers are bid for by the running meter, with unit prices attached for a variation of original quantities.

10. *Statistics.*

Total length of sewers:	Yards.
Main and intercepting	26,889
Branch sewers	202,931

The Geest main collector is 3,380 yards long and tunneled for nine-tenths of its length. It receives the sewage from 200,000 persons, including 35,000 water-closets. The sewers of Altona are 27,888 yards long.

III. IN HOUSES.

Cess-pools are prohibited. Where there are no sewers, casks are ordered for the reception and removal of excrements. Their number is quite small. Where sewers are on the street or being built, connection for sewage and rain-water removal is compulsory. Water-closets are not obligatory, but almost always used.

The house pipes are laid up to the curb line by the department. The remaining part may be done by the owner, but under its supervision.

House pipes must be of iron, vitrified clay, or cement. All closets, sinks, bath-tubs, washstands, &c., must each have a secure trap. The soil pipes are carried beyond the roof for sewer ventilation.

IV. DISPOSAL OF SEWAGE.

All sewage is discharged into the Elbe, under water, into the current.

The sewers from Sanct Pauli and Altona discharge above highest tides; the Geest main sewer and the others at ordinary high water. When tides rise above +17 feet 10 inches their lower ends act as temporary reservoirs for sewage. The quantity of water discharged by the Norder Elbe, which receives the sewage, is 131 cubic yards per second at low water. For a population of 800,000, by calculating 52.8 gallons per head per day, there are 528 gallons of sewage per second, which gives a proportion of 1 part sewage to 50 parts river-water, even with this unfavorable selection of data.

D.—Maintenance of Sewerage Works.

1. *Appliances.*

Sewers are almost exclusively cleaned by flushing. Pen-stocks, gates, &c., are used of different patterns; some are raised vertically, some are hinged on the side, with one door for the smaller and two for the larger sewers. They are placed at intervals averaging 500—1,000 feet apart.

2. *Methods.*

Sewers below the level of the Alster basin, which is 11 feet above low tide in the river, are flushed with its water, which is led into the system at various points. The sewers above the level are flushed by a continuous damming up of the sewage. Water from the city supply is seldom used. At the highest points of each system the sewers act as reservoirs for subsoil water, which is stored and used for flushing.

The low sewers of the Hammerbrook are flushed by water from the canals. The flushing is done by day's work by the department. There are twenty flushers (1 man to 4¾ miles of sewers) which attend to it, including the closing of tide-gates.

All sewers are inspected and flushed at least once every three months, when a detailed return of their condition is made. The greater number are inspected every 9 to 10 weeks. Sewers below the Alster basin are flushed regularly twice a week, others according to necessity. The men begin to flush at the lower end and work upward. The sewers are unusually clean, although many have been 30 to 35 years in use. No disagreeable odor was perceptible in a 4-foot sewer 4 days after flushing.

E.—Cost of Sewerage Works.

1. *Management and maintenance.*

Department for engineering, annual:

Salaries at office	$55,280
Pensions	3,873
Office expenses	11,200
Maintenance of sewers	19,500
Pumping station, Hammerbrook	8,250
Other works of department	417,030
General expenses, printing, library, &c	5,200
Total	$520,333

Assessments upon properties for sewer construction are as follows: If property is improved it is $1.58 per foot front; if unimproved, 68 cents per foot front, but with an additional payment at the time of improvement. For corner lots payment is collected only from the larger front. If a division of property subsequently takes place, a readjustment of the assessment is required, and respectively an additional payment. Corner lots bounded by sewers on three sides pay for one front only, if it is larger than the two others. If it is equal or smaller, the assessment is collected from the two shorter sides. If the property runs through a lot to another street and sewers are built on both, the owner pays only for the larger front of the two, unless he has a connection to both sewers. If connection was made at the shorter side, then upon building the sewer on the longer side the difference is collected. If property is entirely surrounded by streets having sewers, it is considered like two corner lots, payment being collected for the two longest fronts.

Property-owners pay $1.50 for making the sewer connection; also the cost for repairing sidewalks.

2. *Construction.*

The main sewers have cost	\$1,823,000
The branch sewers	2,377,000
Total	4,200,000

The sewers of Altona have cost \$259,500.

FRANKFORT ON THE MAIN.

A.—Statistics of Locality.

1. *Population.*

Year 1880	136,831
Contributing to sewers	95,000

2. *Area.*

	Acres.
City, including river	18,373
Closely built up sections:	
North of river	371
South of river	72
Suburbs, north of river	1,601
Suburbs, south of river	610
City parks, promenades, and gardens	8,599
Farm land and meadows	6,845
River	272
Area supplied with sewerage	1,300

3. *Dwellings, &c.*

Number of houses	6,500
Number of dwellings to one house, average	3.0

4. *Water supply.*

From mountain creeks by gravity. Average daily quantity, 4,226,000 gallons; 31 gallons per head.

5. *Mortality.*

1821–1830	24.5
1831–1840	22.0
1841–1850	19.9
1851–1860	17.6
1861–1870	19.1
1871–1880	21.0

6. *Meteorological.*

	Fahrenheit.
Temperature, mean annual	49.60
Highest monthly average (July)	67.30
Highest 5-day mean (July)	68.86
Lowest monthly average (January)	31.80
Lowest 5-day mean (January)	30.40

Prevailing winds, southwest.

Frost penetrates usually 40 inches; in 1880, January, 52 inches.

Average rainfall, 2 inches.

Maximum rainfalls:

1873, July 6, 30.5 millimeters in 60 minutes = 0.0201 inch per minute.

1875, July 4, 40 millimeters in 100 minutes = 0.0157 inch per minute.

1876, April 2, 18 millimeters in 40 minutes = 0.0177 inch per minute.

7. *Topographical.*

Situate on both banks of river Main, 21 miles above its confluence with the Rhine. The river runs westwardly, and the main part of the town is on the northern bank.

The ground rises gradually from the river, which, during freshets, floods considerable portions. It then forms a plateau on both sides of river, rising from 15 to 30 feet above low water. In the extreme northern and southern parts of the town the ground rises rapidly several hundred feet. The mean flow of the Main is estimated at 6,180 cubic feet per second. Low water at Frankfort is 294 feet above sea.

8. *Physical.*

The old city, which forms a comparatively small part, is very densely built up, with very narrow streets and no garden areas. The newer districts and the suburbs are open, with gardens, public and private; on the site of the old fortifications and moat are promenades surrounding the city. Streets are paved with stone blocks; in the suburbs they are macadamized.

9. *Geological.*

The lower districts are formed of layers of alluvial sand (often quicksand 10 feet deep), loam, and muck; the higher grounds are diluvial, with a tough yellow clay, loam and sandy clay near the surface. The west end of the lower town is built on the old marsh. Subsoil water is abundant, and its level, formerly higher than the sewers, is now kept by them at a lower and more constant height.

B.—Management of Public Works.

The works are managed by several departments, each one of which is under immediate supervision of a committee of city councils and its salaried chairman. There are three regular departments: Streets and parks, Architecture, and Water-supply. The sewerage works are under a special department (temporary), also supervised by a committee. It is in charge of a chief engineer, and is sub-divided into 3 bureaus.

I. Construction and maintenance, with 8 officers.

II. House drainage, with 3 officers.

III. Surveys and registry, with 20 officers.

When works are being constructed additional engineers and inspectors are employed, according to necessity. For maintenance of sewers, 2 foremen, 8 to 10 men, and 2 teams are constantly engaged.

New works are executed under contracts, with intelligent and strict inspection.

C.—Design and Construction of Sewerage Works.

I. GENERAL SYSTEM AND ALIGNMENT.

Combined water-carriage with present discharge into main. Sewage farms proposed.

The system of alignment is that of interception. The territory is divided into two, the high and the low, districts. The latter is situated along the river, and covers the area where cellars are affected by flood-waters; the former comprises the territory above a contour 38 feet above low water.

The high system is divided into bands nearly parallel with the river, each of which is drained by an intercepting sewer near its lower contour. All the high-level interceptors unite to form a main outfall-sewer. At present it usually discharges into the low-level outfall-sewer, except during times of heavy rain, when the sewage is turned through an inverted siphon under the latter directly into the Main.

Storm-water overflow-sewers are carried to the river at various points. When crossing the low district they are laid in the highest streets and discharge as high as possible. The outfall for the lower system was located at a point below the town where the high water in the river is 8 feet lower than opposite the center of the town. As the sewer has a less grade than the river, a lowering of the drainage level of 2 feet in the lowest districts is obtained.

Dead ends are entirely avoided. Every sewer of the lower and upper system is united with one next above it, and finally, at the highest point, with a ventilating stack, of which there are two, one in the eastern and one in the western part of the town. The junctions of the lower with the higher system are securely guarded with pen-stocks (only to be opened for flushing), to prevent a flooding of the low district by water from the upper one at high stages of the river. The system was designed by Mr. W. Lindley, and work was commenced in 1863. It is substantially completed, except portions of the lower district.

II. IN STREETS, ETC.

1. *Shape and size of sewers.*

Pipe sewers are used in sizes of 12 inches and 15 inches diameter. All other sewers are of brick and egg-shaped, except some of the overflow-sewers, which are circular. The smallest brick sewers are 2 feet 10 inches by 1 foot 11 inches. The sizes were governed by three considerations: First, by a maximum quantity of rain to be carried off; secondly, by convenience of construction, as it was found preferable in the many streets which required tunneling to fill the entire space by a brick sewer 2 feet 10 inches by 1 foot 11 inches, instead of by a small pipe, even where the latter would have been sufficiently large, and to pack the remaining space with earth; thirdly, by the grade, for the convenience of cleaning. The intercepting sewers are calculated to receive a rain-fall equivalent to $\frac{1}{4}$ inch in 24 hours plus a daily amount of sewage of 36.7 gallons per person. The overflow-sewers are intended to remove an amount equal to 6 millimeters ($\frac{1}{4}$ inch) per hour, and the various other sewers branching off from the main interceptors to the lower areas, will carry any additional amount of rain-water that may require underground conveyance, which is seldom necessary.

The formula used for calculating the capacity is, in meters:

$$\text{Log. sin. of slope} = \text{log. coeff.} + 1.8 \text{ log. mean velocity} - 1.25 \text{ log. mean radius.}$$

$$\text{or } s = c\,\frac{v^{1.8}}{r^{1.25}}$$

Values for coefficient c are as follows:

Cast-iron and terra-cotta	.00018
Brick	[illegible] to [illegible]

(The coefficient also increases as sewage becomes more concentrated.)

The consideration for cleaning gave the following minimum sizes: When grade is less than 1:500, then size is at least 4 feet 8 inches by 3 feet; when grade is between 1:500 and 1:100, size is 2 feet by 3 feet; for grades over 1:100, pipes 12 inches and 15 inches diameter, are the smallest sizes used.

The ordinary mean velocity in the mains is about 16 inches per second.

Subsoil water is allowed to enter the sewers at certain points.

About 15 per cent. of all sewers are 12-inch and 15-inch pipes. About 55 per cent. are brick, 2 feet 10 inches by 1 foot 11 inches. About 30 per cent. are larger than 2 feet 10 inches by 1 foot 11 inches, and also of brick.

The main northern outfall-sewer is 6 feet 3 inches by 4 feet 7 inches. The main interceptors are 5 feet by 3 feet 3 inches, and 4 feet 3 inches by 2 feet 9 inches, and 3 feet 3 inches by 2 feet 2 inches. The branch sewers are 2 feet 10 inches by 1 foot 11 inches.

2. *Depth and grade of sewers.*

The depth of the sewers is below the lowest cellars. The ordinary depth of cellars is 9 feet 5 inches, and the least depth of sewers is usually 13 feet 1 inch. The greatest depth is usually 19 feet 8 inches. The limits in a few instances are 8 feet and 33 feet, and the average depth is calculated at 17 feet.

The minimum grade adopted is 1 : 2,000, as, for the main low level intercepting sewer. The grades for the other sewers vary from 1 :1,000 to 1 : 50.

Lower intercepting sewers fall from 1:800 to 1:600; upper intercepting sewers from 1 : 200 to 1 : 100. When the grades are greater than 1 : 100, especially when the soil is stiff, pipes are used in preference to brick sewers.

3. *Junctions, connections, overflows, and outfalls.*

Junctions of brick sewers are all made by tangential curves, with large radii, and a chamber with a funnel arch. They are placed at such relative heights as to bring the ordinary flow in each branch to the same level. Pipe sewers are joined in a man-hole.

House connections are made with blocks built into the sewer, at an angle of discharge of 45°. They are generally placed at the level of the ordinary flow of sewage, in order to avoid a drop, and therefore irregular flow and deposit, and are built into the sewer at every property, and temporarily closed if not used.

On account of the peculiar system of alignment, by which all branches are joined to a higher intercepting sewer, and as the branches are to a great extent built 3 feet by 2 feet, or much larger than is necessary for the sewage alone, these branches can be used as overflows for the intercepting sewers. Besides, however, there are special overflow-sewers carried down to the river at various points. They cross the intercepting sewers, generally by inverted siphons, and then receive their surplus water. When passing through the low districts they are laid in the highest streets, to avoid flooding. Where the main outfalls unite there is also an overflow into the river. The outfalls to the system, of which there are to be two on each side of the river, one for the low and one for the high district, are so arranged that the high district outfalls are just below the city, and discharge freely at high water, whereas the lower outfalls are over 3,000 feet below, in order to utilize the greater fall of the river, and thus lower the depth of the sewers in the town. The latter discharge freely during six-sevenths of the year. The outfall is carried 130 feet from shore on the bed of the river, and discharges into the current.

4. *Ventilation.*

The ventilation is through: *a*, rain-water pipes, 4½ inches diameter, whenever the opening is not near a garret window.

b. Soil-pipes, 5 to 8 inches diameter, extending above roof.

c. Street ventilating shafts, 10 inches diameter, of earthen-ware, in all broad streets, at all chambers, junctions, or wherever summits occur; occasionally man-holes are ventilating.

d. Two special shafts at two of the highest points in the system. They are 115 feet high and have a sectional area of several square yards.

e. A small number of factories have agreed to draw the air for the furnaces from the sewers. The odor in the Frankfort sewers is exceedingly slight; even in the ventilating shafts it was not very strong on a cool and rainy October day.

5. *Man-holes, lamp-holes, and flushing-shafts.*

Man-holes are generally built with side entrances except in narrow streets and for pipe sewers, when they are directly over them. In the latter case they are circular and occasionally ventilating. In the former case they have a passage-way 2 meters by 1 meter, from the sewer to the sidewalk with a shaft ascending to it which is closed by a double cover, such as used in Hamburg and London. Man-holes are placed at street intersections: otherwise, every 540 to 600 feet apart for sewers of 5 and 3½ feet and larger, and every 250 to 300 feet for sewers 3 by 2 feet, but generally at bends. Lamp-holes are 9 inches diameter and 100 to 120 feet apart and are placed along pipe sewers between the man-holes. They have a catch-basin at the surface and are ventilating. There are no flushing shafts necessary for the system.

6. *Gullies.*

Gullies are placed in the gutters and have a horizontal grating 18 inches by 13 inches. The cast-iron head is an oblong box, on which the grating is placed, and which narrows to an elliptical funnel at a depth of 12 inches where it is 6 inches by 10 inches in diameter. The head-piece rests on a terra-cotta or iron basin 18 inches diameter extending 7 feet 8 inches below the surface. At a depth of 4 feet 8 inches there is an outlet-pipe 6 inches diameter, which running upward for a short distance forms a trap. An iron bucket is placed into the basin to catch the silt. It is 15 inches in diameter and 2 feet 6 inches high, is perforated by a large number of holes at the top, and can be lifted out by a handle. The gullies are placed at intervals of 120 to 150 feet apart.

7. *Pumping stations.*

No sewage is pumped.

8. *Miscellaneous structures.*

At the highest point of each system is a flushing reservoir in which the sub-soil water is collected and stored. There are four in number and they are circular or egg-shaped in section, vary in length from 750 to 950 feet, and are about 12 feet to 18 feet below surface. Their total capacity is 2,700 cubic yards.

9. *Materials and construction.*

The sewers are built of brick and of vitrified pipe. The materials are of the best obtainable quality. They are carefully examined and every load of cement is tested. The materials are bought by the city and furnished to the contractors. The cement is mixed into mortar by city labor.

Wedge-shaped bricks are used for arches, measuring 9¾ inches by 4¾ inches by 2 to 3 inches for all diameters. Bricks molded to circular curves (both headers and stretchers) are used for man-holes, and rectangular bricks with rounded edges for side entrances, &c. The size of ordinary bricks is 9¾ inches by 4¾ inches by 2½ inches. Brick sewers of 3 feet horizontal diameter and larger are built of two rings of brick (10 inches). Smaller sewers are built of one ring. Invert blocks are quite generally used. They are of terra-cotta mostly; now, concrete is preferred and cut sandstone on curves.

Great care is taken to make the inside surface of the brick-work as smooth as possible by careful lining, accurate centres and smooth joints. Where the subsoil-water was high, parts of the sewer were laid dry. The reservoirs for collecting subsoil-water are laid dry up to the springing line.

Pipe sewers are built of carefully selected and gauged lengths. Half-socket pipes are preferred to others. The joints are made with well puddled blue clay, rarely with mortar. The mortar is mixed of Portland cement and river sand in proportion of 1 : 4.

A large portion of the sewers was built by tunneling, on account of their depth, the narrow streets and the uncertainty of the soil.

Connection-blocks for house drainage are rectangular with a 45° inlet. They are terra-cotta, but lately some have been cast in Portland cement, which is less expensive.

The outlet-pipes into the Main are of cast-iron and extend nearly 50 feet out into the river. The gullies are made of cast-iron or molded in terra-cotta.

The work is executed under contract, the city furnishing the materials and the mortar, and the whole is one of the most carefully built and uniform systems at present in existence.

10. *Statistics.*

Length of sewers	yards..	122,487
Length of gully branches	yards..	13,124
Length of house branches	yards..	17,498
Area drained by lower system	acres..	675
Number of man-holes		700
Number of gullies		2,500
Number of gullies when system is completed		4,200

III. IN HOUSES.

Connection with sewer is not obligatory, but when desired is subject to strict regulations under control and inspection of the bureau, up to the water-closets, sinks, and gullies.

Complete and detailed plans of house drainage must be presented for approval.

The pipes are kept, according to the English principle, as much as possible outside of the buildings. The soil-pipe runs beyond the roof for ventilation of the sewers. All other pipes are trapped against it. The main pipe from the sewer is 6 inches diameter, and is of terra-cotta bedded in clay or concrete 4 inches all round, or it is of iron. The latter must be $\frac{5}{16}$ inch thick, coated with asphalt and jointed with lead; vertical pipes are ¼ inch thick. Soil-pipes are 5 inches diameter, kitchen pipes are 4 inches diameter, rain-water pipes also.

Grades shall not be less than 11:20, but when much steeper there is to be a vertical drop. Terra-cotta pipes must be at least 18 inches below the cellar floor and 39 inches from the nearest wall, and must be jointed with 4 inches of clay inside of the house.

No pipes are to be shallower than 4 feet below the pavement. The drains for points below the highest level of river must be shut off by flap valves. The cess-pools must be filled up after connection has been made with the sewer.

Traps against the main pipe must have a depth of 2¾ inches of water and when outside the house be 4 feet below the surface. Sixty per cent. of all water-closets used are hopper-closets. The rest are the Pan and Jenning closets.

Number of houses connected with sewers	5,400
corresponding to 16,000 dwellings.	
Number of water-closets connected	22,000
Population corresponding to above	90,000

IV. DISPOSAL OF SEWAGE.

The sewage is now all being turned into the river. In the future irrigation, however, is to be attempted.

The outfall is below the town and extends below the river-bed into the current about 130 feet from shore.

The discharge of sewage is estimated at from 30 to 45 gallons per second.

The mean flow of the river Main is estimated at 6,180 cubic feet per second.

The discharge from the most distant points takes place by actual experiment in 3 to 4 hours.

D.—Maintenance of Sewerage Works.

1. *Appliances.*

The sewers are cleaned almost entirely by flushing; it is seldom required to remove deposits by hand. Wherever practicable pen-stocks and flushing-gates are built into the works. There are now about 220 pen-stocks and 320 gates. The low level system is guarded by 40 large additional pen-stocks, made of cast-iron and fitting against planed surfaces. The small pen-stocks which are used only for flushing are of wrought-iron and much lighter. They are operated from the top or from a side entrance. The gates are single and swing to the side.

At the head of each system a reservoir built of perforated bricks collects sub-soil water to flush the sewers below:

One at Bornheim 840 feet long, 5 feet by 6 feet, 22 square feet section.

One at Kettenhof 748 feet long, 22 square feet section.

One at Roederbruch 950 feet long, 22 square feet section.

One at Bockenheim 950 feet long, 5 feet diameter, 17 square feet section.

Temporary reservoirs are built at the dead ends of unfinished sewers. The one at the Bornheim holds 20,000 cubic feet and usually collects 10,000 cubic feet in 24 hours, in rainy weather up to 60,000 cubic feet in 24 hours.

2. *Method.*

The alignment is so arranged that every sewer can be flushed from a higher one or from a reservoir, and so that the entire body from the latter can if necessary be turned through any one of the lower sewers. Each one is flushed about once in three weeks, and from the upper end downward. One foreman and four to five men are constantly engaged in attending to this service. The gullies are cleaned by simply lifting out the buckets and emptying them into a cart, sometimes an after cleaning is necessary. They are cleaned by day and by night, and at intervals from three days to three weeks according to the character of pavement and the weather, but generally about once every two weeks. Three persons and one cart will clean at least 110 basins in the day or 90 in the night. At least 200 are daily cleaned therefore by six men and 2 carts.

The works are in a very good condition.

E.—Cost of Sewerage Works.

1. *Management and maintenance.*

Department for sewerage, annual office expenses:

Construction and maintenance	$10,500
House drainage	2,750
Surveys	8,500
	21,750
For flushing sewers, 1 inspector and 4 flushers	1,750
For cleaning gullies, 6 men and 2 teams	5,000

Assessment on properties for sewer construction is $2.29 per foot of frontage. Corner lots have a deduction, in being exempt from a tax on 66 feet of the longest front.

When sewers are only used for rain-water the properties are exempt from paying any assessment. The yearly tax for water-closets is $1.50 in houses renting for less than $250. In others they are free.

2. *Construction.*

The cost of the sewerage works up to 1880 is $2,100,000, averaging $4.50 per foot of sewer, all except house drainage included.

The cost of the different sewers in marks per meter is equal to about 85 per cent. of the number centimeters measuring the width in clear.

Junction blocks for sewer connections cost 87 cents a piece, bricks cost about $9 per 1,000.

DANTZIC.

A.—Statistics of Locality.

1. *Population.*

Entire	102,000
On sewered district	80,000

2. *Area.*

Drained district ... 1,200 acres.

3. *Number of buildings.*

Number in the town, 4,000; number connected with sewerage, 3,800.

4. *Water supply.*

From creeks, 12,000 cubic meters daily; 32 gallons per head.

5. *Mortality.*

1825–1869, average	36.54
1870–1871, average (sewerage built)	33.33
1872–1880, average	28.59

6. *Meteorological.*

	Fahr.
Temperature, mean annual	45.66
Highest monthly average (July)	64.20
Lowest monthly average (January)	29.27
Highest five-day average (July)	65.12
Lowest five-day average (January)	27.59

Prevailing winds, southwest.

Penetration of frost, 3 feet.

7. *Topographical.*

Situated on the left bank of the Vistula, a few miles above its mouth, and at the point of confluence with the Mottlau. The latter divides the city into two parts, the Niederstadt on the right, the Recht and Altstadt on the left, and by branching, forms in addition, several islands in the city. A small creek, the Radaune, also flows through the town, separating the Recht and Altstadt.

The site is low and flat.

The Niederstadt, to the right of the Mottlau, lies only 4 feet above the river, and is surrounded by dams to guard against floods. The parts on the left bank of the Mottlau are about 12 feet above the river, but rising to 24 feet.

Level of river above Baltic is only 4½ inches.

8. *Physical.*

The town is a fortress, surrounded by moats constantly under water. The greater part of the town is closely built up; the streets are very narrow and winding, with stone-block pavements.

9. *Geological.*

The subsoil is sand, loam, and bog. Houses are extensively built on timber platforms and piles.

B.—Management of Public Works.

The sewerage works entire, as well as their maintenance, including the pumping and the disposal of the sewage on the farm, are under a 30-year contract. They are under the supervision of an executive municipal body, with a consulting and inspecting engineer.

C.—Design and Construction of Sewerage Works.

I. GENERAL SYSTEM AND ALIGNMENT.

Combined water-carriage system, with disposal on sewage farms. The town is naturally divided into three main drainage areas, the Niederstadt, a low and flat district to the southeast, the Altstadt in the north, and the Rechstadt in the southwest. Each one has a main collecting sewer, traversing the district and delivering the sewage at a pumping-station situated on an island in the river Mottlau. The two arms of this river and the Radaune are crossed by inverted siphons, 27 inches and 18 inches in diameter. The main sewer of the Altstadt also drains the Aussenwerke, suburbs east of the town, with which it is connected by an 18-inch siphon under the moat. From the pump, the delivery pipe—of iron, and 22¾ inches in diameter—takes a northeasterly direction to the farms, crossing a branch of the Mottlau, the moat, and the river Vistula by inverted siphons.

The Rawlinson principle of straight lines between man-holes is strictly adhered to. The sewers are laid in the center of the very narrow streets.

The works were designed by Messrs. Wiebe and Latham in 1869, and finished in 1871.

II. IN STREETS, ETC.

1. *Shape and size of sewers.*

The sewers are all pipes, excepting the main collectors or intercepting sewers, which are of brick, and egg-shaped.

Sizes were proportioned to carry off a quantity of rain-water equivalent to ¼ inch in 24 hours, with a great number of overflows into the various water channels intersecting and surrounding the city. The pipe sewers are mostly 9 inches; the minimum size is 6 inches; the maximum, 18 inches. The egg-shaped main sewers are 4 feet by 2 feet 8 inches.

2. *Depth and grades.*

The ordinary depth of the sewers is 10 feet below the pavement, although reaching a minimum of 7 feet. The depth of the intercepting sewers is 9 feet to 20 feet. The grades are as follows:

The main collectors in the Alt and Rechstadt are 1 : 1,500.

The main collectors in the Niederstadt are 1 : 2,400.

The pipe sewers generally range from 1 : 100 to 1 : 200; in the Niederstadt, 1 : 360 to 1 : 600.

The minimum grade for house branches is 1 : 50.

3. *Junctions, connections, overflows, and outfalls.*

The junctions are all made in man-holes. The house connections are provided for by branch pipes, inserted when the sewers were built. The several rivers and their branches, which intersect the city, allow much of the rain-water to run off on the surface. Yet, for the quantity which gets into the sewers, there are 10 overflows provided at different points. They discharge below mean water, and have hanging flaps to prevent the influx of river water during high stages.

The sewage is all collected on the "Kämpe," an island in the Mottlau, and there is lifted to the irrigation fields from a level of 7.2 feet below mean water. The final outfall is at an elevation of 18½ feet above mean water.

4. *Ventilation.*

The sewers are ventilated by 310 man-holes and 118 ventilators in the street. Both were originally provided with arrangements for passing air over charcoal, which now have been abandoned, except at a few points. All soil-pipes act as ventilators to the system; their upper ends, however, are only 2 inches in diameter, reduced from 4 inches. Rain-water conductors are trapped.

To further facilitate ventilation, the grade of the sewer is broken at the man-holes, by which it was expected that the air would rise and escape more readily through them.

5. *Man-holes, lamp-holes, flushing-shafts.*

Man-holes are placed at street crossings, and can be used as flushing-shafts, in being provided with flaps for the entering and discharging pipes, and a chain to open them from the top. The man-holes are placed directly over the sewers, and are covered with an iron grating, into which wooden blocks are set to deaden the noise of passing vehicles. An extra fall of a few inches is given to the sewage in most of the man-holes, and in most cases their bottom forms a shallow catch-pit. The lamp-holes are pipe-shafts, 6 inches and 9 inches in diameter, and have a catch-pit and ventilating-grate at the top.

6. *Gullies.*

Gullies are placed in the gutters, mostly at street intersections and otherwise are 200 feet apart. They are covered with a removable grating 10 inches by 14 inches, and are themselves rectangular, 18 inches by 24 inches, with slightly covered sides. They have a silt-basin, 5 feet 9 inches below the surface, and a trap formed by the 6-inch outlet pipe, which first takes an upward direction after leaving the basin, at a height of 4 feet below the surface.

7. *Pumping stations.*

The pumping station is situated on an island, "the Kämpe," in the Mottlau, to which the sewage is brought by siphons. There are two engines of 60 horse-power, each working one pump. At ordinary times one engine is sufficient, and is in action 14 to 18 hours a day. During heavy rains both operate without stopping. The daily quantity pumped in the first case is 2,641,000 to 2,905,000 gallons; in the latter 3,962,000 to 4,490,000 gallons. The amount of coal consumed is .91 pounds per 1,000 gallons.

8. *Miscellaneous.*

From the numerous water-ways which the sewage crosses, many inverted siphons were necessary: from the Aussenwerke to the Altstadt, 18 inches in diameter; under the Radaune, 20 inches in diameter; under the two branches of the Mottlau, 18 and 27 inches in diameter. The pumping main from the station to the outfall also crosses the moat and the Vistula with inverted siphons, 22½ inches in diameter. They are of wrought iron, and lie about 15 to 18 feet under mean water. Before the sewage enters a siphon it passes through a horizontal screen, which retains all floating matter, and then over a catch-pit, where all heavier particles subside.

9. *Materials and construction.*

The intercepting and main sewers are built of brick, the branch sewers of vitrified pipe, the inverted siphons of cast and wrought iron.

The storm-water overflow pipes along the river are cast-iron pipes, 20 inches to 30 inches diameter and ⅝ inch thick. The main sewers are built of two concentric courses of brick, 9 inches thick. The foundation is concrete, 9 inches below and 12 inches on each side of the brick-work. The concrete often rests on a timber platform. Pipe sewers were also often laid on plank foundations where the soil was soft. Socket-pipes only are used.

Man-holes are built on concrete foundations, 12 inches deep; but they are sometimes built entirely of concrete. Gullies are constructed of concrete altogether, with wrought-iron bands placed in it to tie the whole together.

The construction of the sewers has lowered the subsoil-water from 4 feet below the surface to nearly the present bottom of the sewers. New works, when necessary, are built under a general contract for a long term of years. The city removes all old drainage works in both streets and houses, in case new ones are to be built instead.

10. *Statistics.*

	Yards.
Length of brick sewers (mains)	4,593
Length of pipe-sewers	40,464
Length of inverted siphons	361
Length of pumping-main to farm	3,467

Outlet of pressure-pipe at farm, 18 feet 6 inches above mean water.

Siphon under Vistula, 154 yards long and 18 feet 6 inches below mean water.

For the main (brick) sewers there are 45 man-holes, with side entrances, 18 ventilating-shafts, 10 main-overflows.

For the entire system there are 310 man-holes, 118 ventilators, 420 gullies.

The total retaining capacity of the sewers is about 800 cubic yards.

III. IN HOUSES.

Sewer connection is compulsory. All excrements and waste water must be discharged into them. The branch pipe up to the house line is built by the city at the owner's expense, and is thereafter repaired and maintained by it.

The arrangement of the pipes inside of the house is left to the owner, but it is subject to certain regulations and to the approval and inspection of the city. Detailed plans must be submitted, which, if necessary, will be corrected and altered, and the execution may also be regulated by the city if necessary.

No changes are allowed from approved plans. Every owner is required to flush all pipes in his house, so that stoppages do not occur. The city reserves the right to examine at any time any part of the house drainage and to demand the removal of any defects or such reconstruction as may be necessary. Every inlet must be trapped. Rain-water pipes are not always connected with the sewer or house drainage. The main house-pipes are 6 inches in diameter, with a grade of 1 : 50. Number of water-closets, 12,600.

IV. DISPOSAL OF SEWAGE.

The sewage is all pumped to an irrigation farm near the shore of the Baltic Sea, between the mouth of the Vistula and the village Heubude, about 3 miles northeast of Danzig. The area is about 1,260 acres, of which about 450 acres are at present irrigated.

The soil is little better than beach sand. The surface was very undulating and had to be entirely worked over. The iron pumping-main discharges into an open channel of framed timber, 12 to 20 feet above the lowest points, in which the sewage is carried at a fall of 1 : 2000 toward the shore. From this channel the sewage is tapped on both sides by wooden carriers, 20 inches by 24 inches, in which the sewage is carried over the fields at right angles to the main channel. The area is subdrained, the tiles running parallel to the carriers, and discharging into a collecting channel excavated through the fields for the purpose.

The effluent is clear, without taste or smell, except where passing over a reddish sand common in most parts of the area.

The irrigation is partially broad and partially in furrows. There are no winter basins, as in Berlin, the sewage being passed over the surface in the same manner as in summer.

Grass is not much raised, as there is no demand for it, and hay does not permit the use of much sewage. Beets, corn, tobacco, garden vegetables, and seed culture are considered most profitable. The sewage is distributed by two men. There are 8 attendants altogether for the farm. The temperature of the sewage in summer is about 51°.7 when reaching the fields; in winter it lowers to about 38°, and a thin ice crust is formed on the surface, after entering the open channels and the fields, below which the sewage runs as usual. The mean annual temperature of the sewage is 45°.3. The sanitary condition of the farm has always been good. Irrigation was commenced in 1872 with 19 acres. It was the first trial on the continent.

D.—Maintenance of Sewerage Works.

1. *Appliances.*

The sewers are cleaned mainly by flushing. Pen-stocks, gates, and flap-valves for this purpose are numerous. Every man-hole is provided with the latter.

2. *Method.*

The flushing is very carefully attended to by a gang of six men, who make the entire round in twenty days. It is very efficient, so that rarely other methods are necessary, as cleaning by hand or, by drawning disks through the pipes.

A special pipe, 6 inches diameter and 7,300 feet long, is led around the southeastern part of the city, and supplied with water from the Radaune Creek, and which is solely used for flushing. It passes the heads of all the branch sewers in the Alt and Niederstadt, and its contents can be turned through any of them. Other sewers, those which are lower than the rivers, are flushed with water drawn directly from them. In addition, some sewers are flushed with the water from public hydrants. The sewers are connected whenever possible with each other, so as to use the stored-up sewage of one to flush another. There are seven pen-stocks in the brick sewers and twenty-six valves along the flushing pipe from the Radaune.

E.—Cost of Sewerage Works.

1. *Management and maintenance.*

The maintenance is under a contract for thirty years. Contractor receives free use of all ground needed for irrigation and the income from the farm, in return for pumping the sewage and keeping the sewerage works clean and in repair.

There is no assessment on properties for using sewers.

2. *Construction.*

Cost of sewerage works complete, about $500,000. Cost of preparing fields for irrigation, about $75 per acre.

BRIGHTON.

A.—Statistics of Locality.

1. *Population*, 1880, in sewerage district, 108,000.
2. *Area* affecting sewerage works, nearly forty square miles. Area of town and area sewered about 2,000 acres.
3. *Number of dwellings*, about 20,000.
4. Water supply, from chalk wells, 3,000,000 gallons. Daily average 27.8 gallons per head.
5. *Mortality*, 21.2

6. *Meteorological.*

	Fahr.
1878, mean temperature	50.2
Highest temperature	81.
Lowest temperature	21.
Mean of all daily maximums	56.2
Mean of all daily minimums	44.2
Mean humidity	81.
Rainfall, annual .... inches..	30

1876, June 22, 1 inch fell in 90 minutes during high-water, or 0.011 inch per minute.

7. *Topographical.*

Situate on the south coast of England. The surface of the greater part of the town slopes gradually towards the beach; the other parts are very undulating and hilly, reaching elevations of several hundred feet. A few small creeks, now turned into sewers, pass through the town. The beach road is above the highest tides. Tides range ordinarily within 15 feet, the greatest range is 22 feet, the least 9 feet.

8. *Physical.*

The surface is closely built up in the center, but is open towards the east and west, with parks, gardens, &c. The roads are all macadamized. The area around the town is mostly meadow land and but little is under cultivation. There are sixty-five miles of streets.

9. *Geological.*

Chalk underlies the whole town and crops out in the east, north, and high-lying districts. Westward and in the valleys, it is overlaid with strata of fine sand on the chalk, followed by a layer of bowlders in the east and crushed flints in the west end of the town. Above this is chalky *débris* (coombe-rock), and at some points a stratum of clay.

B.—Management of Public Works.

All public works are in charge of a borough engineer, with six assistants. For maintenance of the ordinary sewers there are one inspector and four men; for the intercepting and outlet sewer there are one inspector and nine men. The sewers are cleaned once a month.

C.—Designs and Construction of Sewerage Works.

I. GENERAL SYSTEM AND ALIGNMENT.

Combined water-carriage system. The sewage is intercepted and discharged into the sea. It is brought to the beach by sewers following the natural depressions of the surface. Along the beach it is intercepted by a sewer beginning at the west end of the town and following the shore eastwardly for a distance of over seven miles to Portobello, where it discharges by gravity. The straight-line principle is followed for the pipe sewers. The intercepting sewer was built from 1871 to 1874. Before it was finished the old valley-line sewers were carried out into the sea beyond low water; yet floating substances returned to the shore.

II. IN STREETS, ETC.

1. *Shape and size of sewers.*

Pipe sewers are used from 12 to 18 inches diameter. Brick sewers have an elliptical shape, except the main interceptor, which is circular. The ordinary section is made of three circles; the radii for the arch and invert are alike, 9 inches, and the sides are flat, their radius varying with the size. The minimum size of pipe sewers is 12 inches diameter; but brick sewers that can be entered, are preferred on account of the great amount of sand and rock silt getting into them, which necessitates much cleaning.

Sewers are made large enough to take a rainfall of ¼ inch per hour. The smallest brick sewers are 2 feet 8 inches by 2 feet; the general sizes are 4 feet by 2 feet and 5 feet 6 inches by 2 feet 6 inches. The main intercepting sewer is 5 feet diameter at its upper end, and 7 feet diameter below the town.

2. *Depth and grades.*

The sewers are comparatively shallow, varying from 6 to 12 feet below the surface. The grades are steep, the minimum for all but the intercepting sewer is 1:40. The maximum grade is 1:13. The grade of the intercepting sewer is 3 feet per mile (1:1760). Its upper end is 21 feet 6 inches above low-water; its lower end is at low-water.

3. *Junctions, connections, overflows, and outfall.*

Junctions are made with easy curves in a chamber with a funnel arch. House connections are at an angle of 30°, a pipe or block being inserted opposite every house. There are three overflows from the intercepting sewer along the shore, the western (4 feet above high-water at spring tides), the central (3 feet above high-water at spring tides), and the eastern (2 feet 6 inches above high-water at spring tides). They act from 3 to 6 times a year, and begin at the moment when the sewer is entirely filled.

The outfall for the sewage is at Portobello, 6 miles east of the town, and discharges freely at low-water of spring tides. The fall for the last mile, nearly, is only 1 foot, but the last 500 feet fall 2 feet, so that the average grade is preserved. At Portobello there is a pen-stock chamber with self-acting valves for shutting out the tide, and two sets of pen-stocks, one to be used when the self-acting valves are out of order, the other to pen back the sewage temporarily to flush the outfall at low water. This chamber has a tunnel passage to the beach. The platform from which to work the stocks, is 3 feet 6 inches above the highest tide. Between the pen-stock and the sea the section of the sewer changes from a circle to a semicircular arch with flat invert, and then again, in an arched chamber, to three iron pipes, each 4 feet diameter, held together in a frame of timber below low-water.

4. *Ventilation.*

Ventilation is obtained through man-holes and special shafts. Charcoal was formerly used in them, but is now abandoned. All chambers and junctions are ventilated.

The air from the intercepting sewer is drawn into a shaft 6 inches diameter and 200 feet high (100 feet above the surface of the bluff under which the sewer passes). The shaft is two miles below the town and draws the air from that distance, all openings on this stretch being carefully closed. At a point 2 miles from the shaft the velocity of the air is about 1¼ to 2 feet per second. The ventilation is facilitated by a furnace placed in the shaft at the surface of the bluff, where a fire is kept constantly burning. The consumption of fuel (coke) is 36 bushels in 24 hours. The odor in the town sewers is not offensive, but in the ventilating-shaft it is very strong, therefore justifying its use.

5. *Man-holes, lamp-holes, and flushing shafts.*

Man-holes are built with rectangular section, 3 feet by 2 feet 6 inches. They are drawn in at the top and covered with a close grating. Connected with it is a ventilating-grating, having a small catch-pit below it, and being placed to one side of the man-hole, as in London. Flushing-shafts are built in the same manner. Lamp-holes are not used.

6. *Gullies.*

Gullies are placed in the gutters and have a horizontal grating 2 feet 3 inches by 1 foot 4 inches. They are mostly made of iron, be-

ing a simple box of the size of the grating, and 2 feet 9 inches deep. A larger size is also used, measuring 1 foot 9 inches by 3 feet 1 inch, and 3 feet 6 inches deep. Still other gullies are made of concrete, 4 feet by 2 feet in section, and 5 feet deep, having a large catch-basin, from which a 9-inch pipe, at a height of 21 inches above the bottom, leads into the sewer. These basins are not trapped. The iron gullies, however, have a trap formed by a hood covering the outlet. The depth of seal is 6 inches, the depth of the basin below the outlet is 1 foot 4 inches, the diameter of the outlet-pipe 9 inches. The inlets are placed from 150 to 300 feet apart.

7. *Pumping station.*

No sewage is pumped.

8. *Miscellaneous structures.*

To avoid steep gradients and chutes, tumbling-bays are used to let sewage drop to a lower level. They are vertical shafts with flags placed alternately on each side, and closing one-half the shaft. They slope 3 inches and are 6 feet apart. The fall is thus broken and no material lodges.

Catch-tanks are built in the main sewers just above the junction with the intercepter, to collect the road-grit from macadamized streets and heavy materials which would otherwise get into it. The tanks vary in dimensions according to the amount of material expected. The tank at the Steyne is 40 feet long, 18 feet broad, and 12 inches deeper than the sewer. The widening checks velocity and thus causes the deposit.

9. *Materials and construction.*

Sewers are built of bricks and pipes. Gault pressed-bricks are used for inverts, and ordinary stock bricks for arches. Blocks, molded of 8 whole bricks and 4 halves, are used in wet ground for the bottom. Wedge-shaped bricks are not used.

Pipe-sewers are laid in a bed of hydraulic-lime mortar 3 inches deep, or cement mortar 2 inches deep. The joints are half-socket and finished in pure cement from 1 inch to 2 inches around the pipe. Many of the sewers are simply lined with a 4½-inch course of bricks, the rest being concrete, finished off at the top to a level 6 inches above the bricks. Mortar is mixed of 1 part Portland cement to 2 parts of sharp sand. Concrete has 5 parts of coarse gravel added.

Man-holes, gullies, chambers, &c., are often made entirely of concrete, smoothly plastered on the inside. The man-holes are drawn in at the top with several courses of brick, and the chambers are arched with a 4½-inch course of brick as a lining. Gullies are built of brick, and also made of cast-iron, the material being ½ inch thick.

10. *Statistics.*

Length of sewers, about 55 miles. Length of intercepting sewer, 7½ miles, of which the upper 9,900 feet are 5 feet in diameter; the next 710 feet are 6 feet in diameter; the next 27,460 feet are 7 feet in diameter, which brings it to the pen-stocks, from which it is 520 feet to the outfall.

The intercepting sewer has 24 side entrances from the beach (6 feet by 3 feet and 2 feet 6 inches), 9 large ventilating shafts or man-holes, and 28 small ventilating shafts, 12 inches diameter, with catch-basins at the top.

For the other sewers there are about 1,000 man-holes and flushing-shafts.

III. IN HOUSES.

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IV. DISPOSAL OF SEWAGE.

The sewage flows to Porto Bello, 6 miles east of Brighton, and there discharges into the ocean about 100 feet from the shore.

D.—MAINTENANCE OF SEWERAGE WORKS.

1. *Appliances.*

Sewers are cleaned by flushing, and the catch-tanks placed in them, by hand. Pen-stocks are used in the large sewers, flap-valves in smaller ones. For pipe-sewers a horizontal iron plate is sometimes built into the flushing-shaft above the pipe, with an opening and stopper, which, when drawn, permits the water to drop through.

2. *Method.*

The town sewers are flushed with water from the city supply. The intercepting sewer is flushed below the Steyne by sea-water at spring tides, which is admitted for 4 or 5 days in succession. The upper end is flushed either by penning back the sewage, or by using fresh water twice a week when there is no rain, or by pumping sea-water.

Pipe-sewers are flushed once a month by attaching a hose to the fire-plugs, and either discharging into sewer directly, or first into the flushing-shafts at the head of the sewer where the entire mass can be dropped at once.

The catch-tanks on the line of the sewers, especially just before discharging into the intercepting sewer, are cleaned of their silt every day or two. This and the cleaning of the gullies is mainly done at night. The sewers are cleaned once a month.

E.—COST OF SEWERAGE WORKS.

1. *Management and maintenance.*

2. *Construction.*

Cost of intercepting sewer and appurtenances, about ..	$500,000 00
Cost per linear foot of sewer, 5 feet diameter, in open cutting	7 00
Cost per linear foot of sewer, 7 feet diameter (9-inch ring), in tunnel	10 00
Cost per linear foot of sewer, 7 feet diameter (15-inch ring), in tunnel	12 70
Cost of ventilating-shafts, per vertical foot, about	5 00

OXFORD.

A.—STATISTICS OF LOCALITY.

1. *Population*, 37,000.
2. *Area*, about 2,000 acres.
3. *Number of dwellings*, 7,000.
4. *Water supply*.—From subsoil water accumulating in a large excavation, up to nearly 2,000,000 gallons per day. Average consumption, 53 gallons per head per day.
5. *Mortality*, 20.4.

6. *Meteorological.*

	Fahrenheit.
Mean temperature (1878)	49.8
Highest temperature (1878)	87.1
Mean of all daily maximum (1878)	56.6
Lowest temperature (1878)	5.6
Mean of all daily minimum (1878)	43.4
Mean humidity (1878)	82

Rain fell on 175 days; total annual, 27.3 inches.
Frost penetrates generally 12 inches; maximum, 2 feet.

7. *Topographical.*

Situate on the river Thames or Isis, where it is joined by the river Cherwell. The site of the town is low and flat, and is intersected by a canal and numerous branches of the rivers. The sewage farm is 3½ miles southeast of the town, on high and undulating grounds.

8. *Physical.*

Only a small portion of the town is closely inhabited; the greater part is open, with comparatively wide streets, gardens, lawns, and open spaces. The roads, 33 miles long, are partly paved, mostly macadamized.

9. *Geological.*

Subsoil consists of gravel and loam, resting on "Oxford clay," which at places rises to the surface.

B.—MANAGEMENT OF PUBLIC WORKS.

All works are in charge of a borough engineer, with necessary corps for design, execution, and maintenance. House drainage must be approved by the engineers.

C.—DESIGN AND CONSTRUCTION OF SEWERAGE WORKS.

I. GENERAL SYSTEM OF ALIGNMENT.

Separate system. The rain-water from 1,900 acres is removed by separate channels, mostly old sewers, and discharged directly into the streams. The house sewage and the rain-water from the remaining 100 acres (roofs and back yards) is led into a new system of sewers and collected at a pumping station 2 miles from the town, where it is raised 57 feet to a sewage farm 1½ miles distant.

The outfall-sewer begins at the river Cherwell, where it is formed by the main sewers collecting and intercepting the sewage from the different sections of the town. Half a mile below, it receives a branch draining New Hinksey, where the water-works are located.

The town itself is divided into four drainage areas: one south of Cherwell is drained by the eastern sewer; one west of it by the north-eastern; one east of the Thames is drained by the northwestern sewer, into which discharges the western sewer from Osney. All pipe-sewers, and those of brick, less than 3 feet high, are straight between man and lamp holes. The works were designed by Mr. White, borough engineer.

II. IN STREETS, ETC.

1. *Shape and size of sewers.*

The rain-water sewers are mostly old and have various shapes; the newer ones are built egg-shaped. The sewers proper consist of pipes from 9 inches to 18 inches diameter, and egg-shaped sewers with the following proportions: Rad. of invert = 1; rad. of arch = 2; rad. of sides = 6; height of sewer = 6. The sizes of the rain-water channels were proportioned according to past experience and judgment. The sizes of the sewers were regulated, taking 9 inches as a minimum in the streets, by estimating the greatest hourly flow to half fill them. (For river crossings see 8.) The outfall sewer varies from 4 feet by 2 feet 8 inches to 4 feet 6 inches by 3 feet. The other main sewers vary from 2 feet by 1 foot 4 inches to 3 feet 6 inches by 2 feet 4 inches. The pumping main is 24 inches in diameter.

2. *Depth and grades.*

The depth of the pipes is between 8 feet and 12 feet below surface. The grades are arranged as much as possible to increase toward the periphery of the area. The pipe sewers have a slight drop of one or two inches at each man-hole. The grades of the branch sewers vary from 1 in 800 to 1 in 100, the greatest number being between 1 in 500 and 1 in 200. The grade of the outfall sewer is 2.31 feet per mile, or 1 in 2,285, for 2¼ miles. The other main sewers vary from 3 feet to 13.2 feet per mile.

3. *Junctions, connections, overflow, outfall.*

Junctions of large brick sewers are made by easy curves in chambers with funnel arches (bell-mouths) and tongues. Junctions of pipe sewers are made entirely in man-holes, with an extra fall of an inch or two from the smaller pipes to the larger. Where mains are too deep for house connections, shafts 6 inches diameter were built at one side of the sewer at intervals of about 40 feet, the top of which forms a brick chamber, into which the house-drains discharge, the sewage descending through the shaft into the sewer. Where lateral sewers have to fall into mains many feet below them, a downward branch is put in a few feet above the junction at a descending angle of about 45° to the bottom of the man-hole. The straight pipe is in this case also continued to the man-hole to have a line of sight. When the quantity of sewage is too great for this arrangement, a flight of steps of blue bricks is built instead. An overflow for accidents is at the pumping-station. The outfall sewer is constructed sufficiently large to hold all sewage accumulating at night.

4. *Ventilation.*

Ventilation is had through man-holes and lamp-holes; also through soil-pipes where not objected to by the owners. All chambers and junctions are ventilated to surface. The odor in the sewers is not strong. The rain-water channels have a slightly foul smell. At the pumping station the odor was only disagreeable near the screens. When the sewage arrived on the farm its odor again was only slight.

5. *Man-holes, lamp holes, flushing-shafts.*

The straight-line principle being strictly adhered to, man and lamp-holes are placed at every change of direction, horizontal or vertical, at every junction and at every summit. They are placed over the sewers, are square in section, and covered with a circular iron grating which has openings for ventilation. From the cast-iron frames in which the grating fits, circular wrought-iron boxes are hung to catch the road detritus falling through the grating. Light wrought-iron ladders are built into the man-holes.

At the head of every line of sewer the man-hole also serves as a flushing-shaft.

Water is laid on from the nearest main by a 1½-inch pipe and screw-down tap. At the bottom of the shaft is a cast-iron flap, which, when lowered, closes the sewer. The tap being opened, the water fills the shaft, and is suddenly discharged, when the flap is raised with a chain from the top.

6. *Gullies.*

The gullies are placed in the gutters, with a horizontal grating 14 inches by 18 inches. They are 3 feet 6 inches deep, and have a trap and catch-pit 18 inches deep below outlet-pipe.

6. *Pumping station.*

The pumping station is situated 2 miles below the town. There are two engines, each 40 horse-power, working a plunger pump. The sewage is raised 57 feet, and the length of the pumping main is 1½ miles. There is also an auxiliary engine of 14 horse-power, with a 12-inch centrifugal pump. Average quantity of sewage pumped daily is 1,500,000 gallons. The pumps are only worked during the day, as the outfall-sewer can store 750,000 gallons during night.

8. *Miscellaneous structures.*

The smaller brick sewers have resting-places, 6 feet high, at certain points, to admit of an upright position. They are specially ventilated. The pumping main is supplied with self-acting air-valves.

9. *Materials and construction.*

The sewers are built of brick and of vitrified pipes. The brick sewers were built with great care and with concentric rings to prevent infiltration of subsoil-water.

Sizes up to 2 feet 6 inches by 1 foot 8 inches in dry ground, have one course of brick laid into a bed of concrete, which reaches to the springing line; the largest size has the concrete extending to 6 inches over the arch. In wet ground the 2 feet 3 inches by 1 foot 6 inches sewer was built of two rings, as were also all of the larger ones. The sewer in the tunnel, 3 feet 3 inches by 2 feet 2 inches, has two courses below the spring and four courses above it, the backing being concrete.

The brick-work was laid in Portland cement mortar, 1 to 1 sand; the concrete for filling spandrils was made of 1 part cement and 6 parts sharp gravel. Eight miles of sewers are laid from 1 to 11 feet below the average summer water-level in the river. The subsoil-water is very abundant. To prevent it from entering the sewers, the ring joints were carefully rendered with cement coats ½ inch thick, as follows:

For the outfall sewers there were 3 coats, two of 2 parts cement to 1 part sand; a third was of pure cement. The smaller sewers had but one coating. The stone-ware pipes were jointed in cement mortar, with sometimes a band of clay puddle in addition. Stanford's patent joint was used where trenches were very wet.

To get rid of the subsoil-water during the construction of brick sewers, pipes, generally 12 inches in diameter, were laid underneath the sewer to the pumps and left in permanently. The inverts, both for brick and pipe sewers, were leveled with extreme care.

Man-holes were built of brick and were covered with ventilating man-hole covers, having wooden blocks inserted. The 24-inch pumping main to the sewage farm is of cast iron, with leaded joints.

A tunnel 202 feet long was driven under the old tower of Oxford castle, lower than the bed of the river and within 6 feet of it horizontally. A tunnel was also driven under the Great Western Railroad.

The numerous streams necessitate many crossings, six under the Isis and Cherwell, one under the canal, and several under minor streams. They are of cast-iron surrounded by concrete.

Two of the river crossings are inverted siphons of iron, with vertical brick shaft on either side of the river. A fall of a few inches is given to them and the lower end has a sump. Sluices are provided for flushing and for detaining sewage in case of repairs. For the two Cherwell crossings, the headway being limited, iron tubes were put in, 1 foot 10 inches by 3 feet 9 inches wide, with segmental top and bottom, and an area of 6.25 feet. The whole was surrounded by concrete. The tube under the Isis has a modified egg shape 2 feet by 2 feet. The sewers under the canal and Trill-mill stream are of brick-work, covered by cast-iron segmental pipes and surrounded with concrete 12 inches to 18 inches.

9. *Statistics.*

	Miles.
Length of brick sewers	7¼
Length of pipe sewers	25
	32¼

Number of man-holes and lamp-holes, over 500.

Discharging capacity of sewers, filled to springing line, is 5,000,000 gallons per day.

In wet weather about 2,000,000 gallons of surface-water gets into sewers, which, with sewage, makes about 4,000,000 gallons.

III. IN HOUSES.

Sewer connection is not yet obligatory, although about three-quarters of all houses are already drained. There are about 7,000 water-closets. The main house pipe joins the sewer about 2 to 3 feet below cellar level.

IV. DISPOSAL OF SEWAGE.

The sewage is delivered on a farm of 335 acres. From the point of discharge it runs partly in open carriers and iron pipes through and around the entire area, crossing some slight depressions by inverted siphons. At various points the sewage is tapped and led into earth carriers (grade 1:1000), which distribute it to the different fields. There are nine sections, comprising 28 acres, which have been leveled and prepared for filter-beds, and which alone could filter the entire quantity of sewage. Five are level and four are on a slope. The remaining ground is used for broad irrigation.

At four termini of the pipe carriers there are tanks, built of brick, 5 feet square, with wooden sluices, from which the sewage is turned into the open carriers. At various places there are movable weirs by which the velocity, if too great, can be reduced, or the sewage dammed up, in order to enable it to spread over the fields. The filter-beds are subdrained, and the sewage drains away freely in a clear and tasteless condition.

D.—MAINTENANCE OF SEWERAGE WORKS.

1. *Appliances.*

Man-holes are used as flushing-shafts at the head of a sewer. At the bottom is a cast-iron flap, which when lowered closes the sewer. At intermediate man-holes grooves are left in the brick-work for the insertion of wooden stops, to obtain a head varying from 18 inches to 3 feet.

In the outfall and other sewers with light grades wooden pen-stocks or doors which can pond up the sewage 5 feet 6 inches high, are placed so as to slide up and down in grooves. They have rack-and-pinion gearing, with a spindle reaching to and operated from the surface of the ground. The man-holes have dirt-boxes hanging under the cover to catch the droppings.

2. *Method.*

The smaller sewers are flushed by water from the city supply. It is laid on from the nearest main by a 1½-inch pipe, and when having filled the flushing-shaft or man-hole is suddenly released on raising the flap by a chain from the top. A good scour is the result. The larger sewers are flushed by sewage dammed up for the purpose by pen-stocks. The latter are also used for laying the sewers partially dry, section by section, for a few hours at a time, to facilitate inspection. By this means the sewers are kept in a very good condition.

The dirt-boxes hanging from the man-holes and gullies which connect with the rain-water sewers, as well as the latter themselves, are cleaned frequently.

E.—COST OF SEWERAGE WORKS.

1. *Management and maintenance.*

* * * * * * *

2. *Construction.*

Cost of subdraining sewage farm, $87 per acre; cost of land for farm, $456 per acre; cost of total preparation for irrigation, $171 per acre.

AMSTERDAM.

A.—STATISTICS OF LOCALITY.

1. *Population* 1880, 304,000; population using Liernur system, 27,600.
2. *Area*, 1,606 acres.
3. *Number of dwellings*, 32,000.
4. *Water supply*, 10,000 cubic meters daily, obtained from the Harlem dunes. Per day per head, 8.44 gallons.
5. *Mortality*, mean for 10 years, 24.8; in 1878, 24.4.

6. *Meteorological.*

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7. *Topographical.*

Situate on an arm of the Zuyder Sea at the mouth of the Amstel, a small river passing through the city in several arms. The city is, in addition, intersected by numerous canals, dividing it into 90 islands. It is almost on a level and only slightly above high tide.

8. *Physical.*

The city, from the numerous canals in all directions, is rather open. A few of the central districts are, however, very crowded. The streets are all paved. They are narrow in the central parts. Toward the periphery (where the Liernur system of sewerage is applied) the streets are wider and airy.

9. *Geological.*

The subsoil is mud, loam, and loose sand, resting on clay at a depth of 20 to 50 feet. The site was originally a peat-bog. All buildings rest on piles.

B.—MANAGEMENT OF PUBLIC WORKS.

All public works are supervised by an alderman (échevin). The departments for design, construction, surveys, and repairs are under the guidance of a director, and are subdivided into bureaus for streets, parks, canals and sewers, buildings, &c. Water and gas are furnished by private parties. The department for city maintenance is to a certain extent independent of the former and includes the cleaning of streets, canals, and sewers (not Liernur system). The bureau of streets, parks, canals, and sewers is charged with all engineering works, including the design, construction, and maintenance of the Liernur system. It is under a chief engineer, assisted by one adjunct and four principal assistants, one for streets, one for parks and public promenades, one for canals and sewers, and one for the Liernur system. In addition there are about 20 assistants. For the Liernur system there are 3 machinists and 16 men for maintenance.

C.—DESIGN AND CONSTRUCTION OF SEWERAGE WORKS.

I. GENERAL SYSTEM AND ALIGNMENT.

Pneumatic separate system (Liernur) for the removal of excrementitious matter of a small portion of the town. Dry removal in pails, holding 8 gallons, and exchanged daily, for the rest of the town.

Storm-water runs entirely over surface or into old sewers.

The Liernur pipes, which are of iron and into which the houses drain, unite every several hundred feet at street intersections in an air-tight reservoir, into which the sewage is drawn by means of a vacuum created in it through a pipe leading to the air-pump or central station. After the sewage from the several branches is collected in the reservoir it is again drawn by a vacuum to the central station itself, where it is run into barges and removed. Usually there is only one branch pipe for a street; occasionally there is one on each side. The main pipes from the reservoirs to the air-pump, which are not connected with the houses, are additional, which altogether makes two pipes in about one-half of all the streets.

The sewage frequently passes twice over the same block, first being drawn into the reservoir and then through another pipe back again partially through the same street to the central station. The sewage collected by the Liernur pipes is very dilute, 50 parts fluid to 1 part solid, notwithstanding that precautions are taken against the introduction of much water. Where the system is applied to single and scattered houses the pipes are emptied by pneumatic carts when in the blocks, and by a steamboat when near the canals.

The cart and boat carry a cask. A vacuum is created in it in both cases by a pump attached to the cart or on the boat, and the sewage is drawn into them. The entire system was designed by Captain Liernur, and introduced in 1871.

II. IN STREETS, ETC.

1. *Shape and size of sewers.*

The shapes of the old sewers for rain and house water vary; they are mostly circular, from 1 foot to 2½ feet in diameter. The Liernur sewage pipes are circular and all 5 inches diameter, both branches and mains.

2. *Depth and grade.*

The depth of the rain and house water sewers is about 6 feet; the depth of the Liernur pipes is very shallow, averaging 1 meter. The grades of the sewers range from 1 in 500 to 1 in 200; for house drains 1 in 50. The grades of the Liernur pipes do not affect the velocity, yet it is preferred not to make them level. The discharging mains from the reservoirs to the pumps have a fall of 1 in 800; the branch pipes leading into the reservoirs have a fall of 1 in 200 to 1 in 150.

3. *Junctions, connections, overflows, and outfall.*

The junctions of the main Liernur pipes are made in iron chambers (reservoirs), cylindrical in shape, about 7 feet long and 4 feet diameter. The inlet-pipes enter near the top; the discharge-pipe also enters near the top but is extended through the cylinder into a depression at the bottom, 4 inches deep, so that it can draw out the sewage to the greatest possible extent. The reservoir is provided with the necessary valves for inlet and outlet pipes. The house connections are at right angles and have one or more "barometrical traps" (siphon traps with a constant depth for the entire system) before entering the house. Overflows are of course not required. The outfall of each district is at the air-pump, and is situated at a canal where the sewage is turned into barges. The outfalls for those houses which are relieved by an air-pump on a boat are of course also along the canals.

4. *Ventilation.*

Ventilation for the Liernur system is only necessary at the pump, where the air is carried through the fire, or escapes from a high chimney. The odor is intense without either precaution.

5. *Man-holes, lamp-holes, and flushing-shafts.*

These structures are not required for the Liernur system. Access to the pipes is only had by breaking into them.

6. *Gullies.*

As no street water runs into the Liernur system, no gullies are required for it. There are very few in the town, because the rain-water runs on the surface to the numerous canals.

7. *Pumping-station.*

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8. *Miscellaneous structures.*

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9. *Materials and construction.*

The sewer pipes, chambers, and reservoirs, are all made of cast-iron, and carefully joined with lead joints in order to be air-tight.

10. *Statistics.*

Length of main pipes from reservoirs to pumps, about 3,160 yards.
Length of branch pipes, about 8,780 yards.
Number of reservoirs, about 15.
Number of independent districts for which system is used, 5.
Number of houses drained. 1,190.

III. IN HOUSES.

In the older part of the city, cess-pools are still in use with overflows into the canals, when near them. All house and rain water runs into the canal. In the newer sections of the city both the cask and Liernur systems are used. The casks receive both solids and liquids. The pipes leading away the waste water are generally 12 inches diameter, and of terra-cotta. The pipes for the Liernur system are of iron, 5 inches diameter, and have several traps (barometric) on the line. The soil-pipe is carried beyond the roof, and also a special ventilating-pipe for each closet. The closets are of the hopper style, and only such, of a water-saving character, are allowed. Nothing but water-closet contents get into the Liernur pipes; other matter is led over the surface or into the rain-water sewers. Each house can be disconnected from the street system, in case of repairs, by a hand-valve.

IV. DISPOSAL OF SEWAGE.

The contents of the casks are removed to neighboring farms. The Liernur sewage is discharged into boats, by which it is taken to near farms, where it flows over some fields in a very unsystematic way, and so far without financial success. Only a slight and uncertain return is had from it. At present the sewage is often mixed with street-sweepings, and in this way sells for 30 cents a cubic yard delivered, or with the contents of casks, in equal parts, when it sells for 60 cents a cubic yard delivered.

D.—MAINTENANCE OF SEWERAGE WORKS.

1. *Appliances.*

There are three stationary engines and one steamboat for the Liernur service. They are alike supplied with air-pumps, receiving-tanks, &c.

2. *Method.*

The sewage is drawn to the receiving-tanks and conveyed away as described above. The pipes are emptied once every week-day, some also on Sundays. Flushing or other method of cleaning is not practicable nor necessary, as the process of removing sewage keeps the pipes in order. Stoppages occasionally occur, and they are usually relieved by breaking into pipes. The attendance upon the system consists of 3 machinists, 2 stokers, and 4 laborers for the 3 engines, and 1 machinist, 1 stoker, 1 captain, and 2 laborers for the steamboat. In addition, 2 persons attend to the reservoirs and valves, and operate the collection of the sewage.

In 1880 there were 7,253,602 gallons of sewage collected and removed. Daily average per person, 0.74 gallons.

E.—COST OF SEWERAGE WORKS.

1. *Management and maintenance.*

Running cost of Liernur works in 1880.

	Persons.	Total cost.	Cost per head per year.
Fixed stations	21,939	$4,773	$0 22
Steamboat service	4,656	3,919	0 84
Pneumatic carts*	1,351	2,166	1 60
Total	27,946	10,858	=0 39

* Not Liernur system proper.

Cost of maintenance of Liernur works up to 1877, excluding transportation of sewage in boats and utilization, 45 cents per year per head. Cost of maintenance of cask system, 73 cents per year per head. Return from sale of Liernur sewage in 1877, $522.

In 1880 it was not salable unless prepared, as follows: When mixed with contents of casks in equal parts it sold for 60 cents per cubic yard delivered. When mixed with street sweepings it sold for 30 cents per cubic yard delivered.

Assessment for system: City paid for the pipes up to 20 inches from house line; owners paid the rest. The latter pay an annual rent of $3.25 for connection, also 12 cents per hour of labor necessary to remove obstructions in the house-pipes.

2. *Cost of sewerage works.*

The Liernur works entire have cost $124,500; the Liernur house-fittings, $70 to $90, including pipes, per dwelling.

APPENDIX No. 2.

MAXIMUM RAINFALLS.

Place.	Date.	Total fall.	Length of storm.	Fall per minute.	Author.
		Inches.	*Min.*	*Inches.*	
London	Aug. —, 1846	3.3	140	0.024	....
	Aug. —, 1846	2.0	30	0.067	....
	July —, 1852	0.5	15	0.033	....
	Oct. —, 1857	2.92	2,160	0.0013	(2)
	June —, 1874	0.96	30	0.032	....
	June 23, 1878	3.0	90	0.033	....
	July 14, 1880	*0.36	12	0.930	....
	(?)	6.0	90	0.067	(6)
Paris	July 16, 1860	1.496	20	0.0740	....
	May 23, 1865	1.024	20	0.0512	....
	July 16, 1866	1.260	30	0.0420	....
	Sept. 20, 1867	1.614	20	0.0807	....
	May 22, 1870	1.024	60	0.0171	....
	July 27, 1872	1.575	60	0.0262	....
	Aug. 15, 1879	0.642	40	0.0160	....
Berlin	July 11, 1858	2.560	840	0.0030	....
	(?)	0.787	20	0.0393	....
Vienna	June 23, 1853	0.8819	60	0.0150	....
	July 19, 1854	0.843	60	0.0140	....
	May 2, 1860	1.025	110	0.0175	....
	July 18, 1870	1.598	140	0.0114	....
Hamburg	(?)	0.827	45	0.0184	....
Frankfort	July 6, 1873	1.201	60	0.0201	
	July 4, 1875	1.575	100	0.0154	
	April 2, 1876	0.709	40	0.0177	
Liverpool	Greatest observed rainfall, 1878.	0.750	60	0.0125	
Brighton	June 22, 1876	1.00	90	0.011	
Kiel	Aug. 4, 1879	1.457	10	0.1454	
	Oct. 3, 1879	0.929	20	0.0465	
Brussels	June 4, 1839	3.3850	180	0.0188	
		4.2718	540	0.0079	
Clausthal	June 11, 1858	4.130	1,080	0.0038	(1)
	Dec. 16, 1854	2.225	780	0.0028	(1)
Brocken	July 31, 1858	4.961	?1,440	0.0035	(1)
Güterslohe	July 19, 1852	3.556	?720	0.0049	(1)
Dresden	June 9, 1862	0.851	20	0.0425	(1)
Posen	July 26, 1863	0.949	20	0.0475	(1)
Königsberg	July 13, 1878	1.59	135	0.012	Wiebe.
	Aug. 17, 1878	2.43	?720	0.0034	Wiebe.
Zechen	May 13, 1858	1.744	60	0.029	(1)
Breslau	Aug. 6, 1858	3.740	120	0.0312	(1)
Genf	May 20, 1827	6.394	180	0.0355	(1)
Salzwedel	Aug. 18, 1862	3.071	165	0.0186	(2)
Verviers	Sept. 26, 1801	14.071	1,080	0.0130	(1)
Montpelier	(?)	5.118	360	0.0213	(2)
Togense	Oct. 9, 1827	31.072	(?)	(?)	
Marseilles	Sept. 21, 1838	1.574	25	0.063	(2)
	(?)	13.0	840	0.0155	(6)
Geneva	May 30, 1827	6.378	180	0.0352	(4)
	(?)	6.0	180	0.0333	(6)
Genoa	Oct. 25, 1822	31.976	1,440	0.0222	(1)
	(?)	32.0	1,440	0.0222	(6)
Budapest	(?)	2.55	60	0.043	(7)
Munich	(?)	2.0	30	0.067	(7)
Switzerland	(?)	2.0	30	0.067	(7)
	(?)	0.875	10	0.087	(7)
Catskill, Hudson	July 26, 1819	17.993	450	0.040	(5)
Havana	July 18, 1854	2.815	150	0.0187	(2)
Cayenne	(?)	11.024	600	0.0184	(2)
Washington	(?)	2.0	40	0.050	
Philadelphia	July —, 1842	6.0	120	0.050	(6)
Norristown, Pa	(?) 1865	9.0	300	0.030	(6)

* Nearly

REFERENCES.

(1) "Die Regenverhaltnisse Deutschlands," von Dr. Jacob van Bebber, 1877.
(2) Klassen "Entwaesserung."
(3) Preussische Statistic. Heft, 54.
(4) Dr. Marbach's Physical Lexicon, 1858.
(5) Pogendorf's Annalen, 1848, p. 512.
(6) Trautwine's Pocket-book.
(7) Burkli-Fiegler. Abflussmengen städtischer Canäle, 1878.

DEDUCTIONS.

Largest quantities of rainfall occur in the summer, and usually extend over large areas. Variations of quantity increase with the elevation above the sea. Rainfalls in or near elevated regions are generally greater than in low and flat regions. More rainfalls occur in warm than in cold countries.

APPENDIX No. 3.

CATALOGUE OF PUBLICATIONS RELATING TO SEWERAGE.

COMPILED BY RUDOLPH HERING, C. E.

I.—ENGLISH LANGUAGE.

CLASS A.—*Books and pamphlets, including articles from periodicals published separately in book form. Classified according to authors and in a few instances to places and subjects.*

ADAMS, J. W.—Sewers and drains for populous districts. 8vo., 228 pp. New York, 1880. $2.50.
——— *See* CLASS B. BROOKLYN.
AMERICAN PUBLIC HEALTH ASSOCIATION.—Proceedings of the———.
AUSTIN, HENRY.—A few points in relation to the drainage of towns. "Transactions of the National Association for the Promotion of Social Science." 1857, p. 422–429.
——— *See* CLASS B. CROYDON, UTILIZATION OF SEWAGE.
BANNER.—Wholesome houses.
BARDWELL.—A brief account of Mr. Bardwell's Improved Method of Utilizing Sewage and Urine, and for facilitating their passage through pipes to prevent the pollution of rivers and streams. 6*d.*
——— Twelve reasons against sewage irrigation. 3*d.*
BARRY, T. D.—Present state of the sewage question. 8vo., 18 pp. Liverpool, 1870. 1*s.*
BAYLES, J. C.—House drainage and water service in cities, villages, and rural neighborhoods. Roy. 8vo., 350 pp. New York, 1878. $3.
BAZALGETTE, J. W.—Lecture on the main drainage of the Metropolis. 8vo., 41 pp. 1857.
——— Main drainage of London. Proceedings of the Institute of Civil Engineers. 8vo., 92 pp. London, 1865.
——— West Metropolitan Main Drainage Works. "Engineer," 1873, vol. 36, pp. 95–99–102–136–169–256.
——— The Sewage Question. Proceedings of the Institute of Civil Engineers. 8vo., 192 pp. London, 1877.
——— *See* CLASS B. CAMBRIDGE, METROPOLITAN M. D.
BELL, R.—Objections to Bazalgette's scheme for the drainage of the Metropolis. 8vo. London, 1856.
BIRCH.—Disposal of Town Sewage. 8vo., 36 pp. London, 1870, $0.50.
BIRCH, R. W. P.—Sewage Irrigation by farmers, or fifty instances of profitable sewage utilization. 8vo. London, 1878. 2*s.* 6*d.*
BIRD, P. H.—Hints on drains, traps, closets, sewer-gas, and sewage disposal. 8vo. London, 187–. 2*s.* 6*d.*
——— Ventilation of house-drains, soil-pipes, and sewers.
BIRMINGHAM.—The sewage of ———. "Engineer," vol. 32; 1871; No. I, p. 329; No. II, p. 355.
BLAKE.—Sewage-poisoning. How to avoid it in the cheapest and best way.
BOULNOIS, H. P.—Sewer ventilation. Improved system for disposal of noxious gases from sewers. 8vo., 16 pp. Exeter, 1880. 6*d.*
BROOM, G. C.—Wolverhampton sewerage scheme, and hints on the ventilation of house drainage. 8vo., 50 pp. London, 1878. 1*s.* 6*d.*
BUCHAN, W. P.—A text-book to the practice of plumbing and house drainage. (Weale's series.) 12mo., 232 pp. 300 illustrations. London, 1880. 3*s.* 6*d.*
BUCK.—Treatise on Hygiene and Public Health. 2 vols., 8vo. New York, 1879.
BUCKHURST, HILL.—Sewage, utilization of———. "Engineer," 1872, vol. 34, p. 207.
BURKE, W. RALPH.—A Handbook of Sewage Utilization. 8vo., 60 pp. London, second edition, 1873. 3*s.* 6*d.*
BURN, SCOTT.—Utilization of sewage, irrigation and reclamation of waste land. 2*s.* 6*d.*
CARPENTER, Dr. A.—Preventive Medicine and Public Health. Lectures on Beddington sewage-farm, &c. 12mo. 367 pp. London, 1877.
——— *See* CLASS B. CROYDON.
CHATTERTON. *See* GOWER. IN CLASS B, *see* CAMBRIDGE.
CHAUMONT.—Healthy habitations.
CHESBROUGH, E. S.—Sewerage; its advantages and disadvantages, construction, and maintenance. From eighth annual report of the State board of health of Massachusetts. 8vo. Boston, 1877.
——— *See* CLASS B. BROOKLINE, CHICAGO, NEW HAVEN.
CHILD, Dr. GILBERT W.—The present state of the town sewage question, 8vo., 34 pp. Oxford, 1865.
CLARKE, E. C.—Common defects in house-drains. 8vo. 24 pp. Boston. Extract from State board of health reports, 1879.
CONCRETE.—Bournemouth Drainage. Vindication of the Rock Concrete Tubes. 8vo. London, 1879. 1*s.*
COPELAND, JAMES.—Drainage and sewerage of London and large towns; their evils and cures, 12mo., 33pp. London, 1857.
CORFIELD, W. H.—Digest of facts relating to the treatment and utilization of sewage. 8vo., 343 pp. London, 1871. 10*s.*
——— Lecture on Water Supply, Sewage and Sewage Utilization. London, 1875.
——— Laws of Health. 12 mo., 152pp. London, 1880. 18*d.*
——— Sanitary Construction of Dwellings.
CROOKS, WM.—Experience with the A B C process of purifying sewage. 8vo., 8 pp. London, 1872.
CROOKS, WM.—Recent trials of the A B C process made at Leeds. 8vo., 8 pp. London, 1876.
——— The Profitable Disposal of Sewage. 8vo., 18 pp. London, 1876.
DANCHELL, F. H.—Concerning Sewage and its Economical Disposal. 8vo., 40 pp. London, 1872. 1*s.*
DEMPSEY, DRYSDALE.—Rudimentary treatise on the drainage of districts and lands. 12mo. London, 1854.
DEMPSEY, J. J.—The Metropolitan main drainage question. What has been done and what is to be done. 8vo. London, 1858.
——— Rudimentary treatise on the drainage of towns and buildings. 12mo., 250 pp. London, 1867. 2*s.* 6*d.*
——— Drainage of districts and lands, 12mo. London, 1869. 1*s.* 6*d.*
DENTON, J. BAILEY.—Sewage farming. 1870.
——— Sewage the fertilizer of land, and land the purifier of sewage. 1871.
——— Intermittent downward filtration and irrigation. 1873.
——— Sanitary science applied to towns and rural districts. 1874.
——— Sanitary Engineering. Roy. 8vo., 429 pp. London, 1877. £1 5*s.*
——— House Sanitation, Water Supply, and Domestic Filtration, 8vo., 16 pp. 1879.
——— Intermittent Downward Filtration, *per se*, and in combination with Surface Irrigation. 8vo., 30 pp. London, 1880. 1*s.*
——— Ten years' experience in Intermittent Downward Filtration. 8vo., 78 pp. London, 1880.
——— Sanitary Works and Sewage Utilization. 8vo. London. 1*s.*
——— The Sewage Question. 8vo.
——— Under-drainage of land, its development and maintenance. 8vo.
DONALDSON, GEO.—Drainage of the town of Richmond, Surrey. Proceedings of the Institute of Civil Engineers. 8vo., 17 pp. London, 1856.
DOWNES.—How to avoid Typhoid Fever and allied diseases. Plain rules on House Drainage.
DRAINAGE.—A scheme for the Effectual Drainage of towns, with projects of important natural measures which may be ingrafted upon it. 8vo., 42 pp. Plates. London 1855.
DRYSDALE and HAYWOOD.—Health and comfort in house-building. 8vo., 129 pp. London, 1876.
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REPORT ON DIPHTHERIA.

[BY DRS. H. C. WOOD AND H. F. FORMAD.]

PREFACE.

During the spring, summer, and autumn of 1880 the work forming the basis of the following report was prosecuted very actively, and the results obtained were published by the National Board of Health. Last March we resumed our labors, and have done all that we could during the summer. In the winter it is almost impossible for us to get time for original research; and although the etiology of diphtheria cannot yet be considered as thoroughly worked out, it has been thought best to present our report upon what has been accomplished, and in the report to embody that portion of the work of 1880 which is logically necessary to the completed whole. It has also seemed to us that our monograph would be much more valuable and effective if we should collect the scattered, and to very many physicians inaccessible, literature of the subject. We have therefore prefaced the main text with an introduction which is thought to contain an epitome of all that has been hitherto discovered concerning the relation of low organisms to diphtheria

We desire here especially to express our thanks to Dr. P. P. Short, of Ludington, Mich. It was only through his strenuous exertions that it became possible to study the Ludington epidemic.

CHAPTER I.

BIBLIOGRAPHICAL INTRODUCTION.

(A.) IN FAVOR OF THE FUNGOID ORIGIN OF DIPHTHERIA.

OERTEL (*Studien über Diphtheria*, Arztl. *Intelligenzblatt*, 1868, No. 31) was the first to speak of micrococci as occurring in diphtheritic pseudo-membrane, and also in the blood, the lymphatic vessels, and the kidneys of persons affected by diphtheria. He describes them as "point-like, dark-contoured, round or oval (immovable)" little bodies, occurring either isolated or in zooglœa form. Later (*Deutsches Archiv f. Klin. Medicin*, 1871, p. 242, and in *Ziemssen's Encylopœdia*, 1874), Oertel describes the diphtheritic fungi to be spherical bacteria (micrococci, accompanied by a larger or smaller quantity of bacterium termo). He thinks that they are the direct cause of the diphtheritic inflammation; that long before any false membrane is formed they attack the mucous membrane and induce the disease.

Oertel experimented as follows:

First series.—Produced ammonia croup in rabbits; found few or no micrococci in the false membrane, and never any in the blood and organs. Hence he thinks that croup must be strongly separated from diphtheria.

Second series.—He inoculated with true diphtheritic matter in the trachea, twelve rabbits, three pigeons, and two chickens; and produced local lesions and constitutional disturbances perfectly identical with those of diphtheria in man; micrococci were found abundant in the blood of the poisoned animals.

Third series.—He inoculated rabbits with true diphtheritic matter, placing the poison below the skin and in the muscles, with the same results as in the second series.

Fourth series.—He inoculated rabbits with pyaemic pus and gangrenous tissues with negative results.

Fifth series. — He succeeded by inoculations in the trachea in transmitting the disease—

1st. From man to rabbit No. 1.

2d. From rabbit No. 1, to rabbit No. 2.

3d. From rabbit No. 2 to rabbit No. 3.

4th. From rabbit No. 3 to a pigeon.

5th. From the pigeon to rabbit No. 4.

All the animals died with lesions peculiar to diphtheria within thirty to forty hours.

How the bacteria acts he says is not known.

Oertel further affirms that the quantity of fungi present in any case bears a direct relation to the intensity of the morbid process; they multiply as the disease advances and diminish with its retreat. Also, that the special form of fungus is never present in simple inflammation of the fauces or in mercurial stomatitis; but that, if the diphtheritic process intervenes on these disorders, the fungus at once makes its appearance, and quickly displaces the more common forms of bacteria which are present.

NASSILOFF (*Virchow's Archiv*, vol. 50, 1870), from his observations and experiments, came to the conclusion that the fungi found in diphtheria are identical with those occurring in decomposing animal tissues. His conclusions are:

(1.) Fungi are always present in diphtheritic membranes.

(2.) The development of the fungi precedes the formation of the membrane, and the fungi are the direct cause of the necrotic changes in diphtheritic inflammations.

(3.) The fungi penetrates into the tissues by way of the juice channels and lymphatics before any changes in those tissues can be observed, so that fungi are the cause of the inflammation and the destruction of the parts affected.

HUETER AND TOMMASI (*Med. Central Blatt*, 1868, No. 12 and 34), also established by experiment the direct causitive relation of micrococci to diphtheria. They placed particles of diphtheritic membranes in the muscles of the back of rabbits. Death followed promptly within forty hours. The tissues at the seat of inoculation were inflamed and invested by very small, roundish micrococci. The latter were found also during life in the blood of the infected animals.

TRENDELENBURG (*Arch. f. Klin. Chirurgie*, 1869, vol. 10) put diphtheritic matter in the trachea of rabbits and pigeons. He succeeded in producing false membrane only in eleven out of sixty-eight experiments; in the blood of rabbits inoculated with diphtheritic matter he frequently found micrococci, sometimes even in those animals in which a distinct false membrane had failed to appear. Frequently, but not always, he found micrococci in the blood of children suffering from the disease.

Trendelenburg doubts whether the micrococci as found in the blood of diphtheritic patients are peculiar to diphtheria, and does not believe it to be a proof of the transmission of diphtheria to animals if at the seat of inoculation a diphtheritic inflammation is produced.

EBERTH (*Correspondenz-Blatt der schweizer Aerzte*, No. 1, 1872) discovered in 1871 micrococci in the blood and the tissues of persons who had died of diphtheria, but was not able to detect the fungi in the blood or even in the false membrane of patients suffering from true croup.

Experimentally he succeeded in reproducing diphtheria in animals, which died in three days.

Diphtheria of wounds, Eberth thinks, stands in close relation to pyæmia. Pyæmia, he says, "is a diphtheria proceeding from a wound." The bacteria of diphtheria and pyæmia he believes to be identical.

LETZERICH (*Virchow's Archiv*, 1873, Vol. 58) claims to have produced local and general diphtheritic lesions with the fungi filtered out from the urine of individuals suffering from that disease. When the dried urine-filter, with the pure fungi on it (all other foreign matter having been washed out by means of hot water), were introduced into the uninjured mouths or vaginas of rabbits, diphtheritic pseudo-membranes and death followed in from three to five days.

He describes the fungus as occurring in four forms.

First. Constituting small balls composed of a hyaline substance, which is colored blue by iodine and sulphuric acid, and of small punctiform roundish or elliptical little bodies, which may increase until the whole mass becomes very dark.

Second. Large balls "*Plasmakugeln*" with a seeming outer membrane.

Third. Large irregular masses formed by the bursting of these balls.

Fourth. True mycelial filaments which produce spores of a tilletia, and are named by Letzerich *Tilletia diphtheritica*.

COHN (*Beiträge zur Biologie der Pflanzen*, 1872 and 1873), who regards bacteria as algæ, classes the diphtheritic plant with the schizophytes; tribe, sphaero-bacteria, and calls it *Micrococcus diptheriticus*. He gives as its specific character: Perfectly round, less than one micromillimeter in size; in multiplying, first forms in pairs, then several joints, then chains, and finally zooglaea masses, but never any mycelium.

KLEBS (*Correspondenz-Blatt der schweizer Aerzte*, 1871, No. 9) thinks that micrococci do develop a *mycelium* resembling *Leptothrix buccallis*, but somewhat thinner or more delicate than it is. This diphtheritic mycelium forms on the surface of affected membranes dense bunches upon which spores are produced. The latter collect in masses in zooglaea form of various size and shape. Between these groups occur free micrococci ("*Monades*"), micrococci chains, and rod bacteria. The greatest destruction of tissues is produced by the zooglaea.

Klebs agrees with Eberth concerning the identity of diphtheritic

and septic micrococci. In his latest publication (*Archiv für Experiment. Pathologie, und Therap*, Vol. 4, p. 191), Klebs describes the diphtheritic fungi as follows:

First stage.—Very small micrococci forming in the quiescent state sharply defined round balls, the individual micrococci being united in rows or chains and imbedded in a very scanty gelatinous matter.

Second stage.—Peripheral layers of the micrococci balls give rise to mobile bacteria, which do not need much oxygen, and have a tendency to penetrate into and live within the tissues and juices where not much oxygen is present.

Third stage.—The highest form of development consists in the formation of a mycelium in the tissues. The threads are never branching, and arrange themselves, parallel to one another, covering the outer surfaces like the grass in the turf. Occasionally mycelium masses may form in deeper structures of the organisms.

Professor Klebs also gives the following as peculiarities in the life-history of the diphtheritic fungus:

(*a.*) They can grow and develop without oxygen.

(*b.*) They are killed only by a temperature of 65° to 70° C. (Not below that).

(*c.*) In themselves they do not develop any fœtid gases.

(*d.*) They are sometimes of intensely yellow color.

(*e.*) They may circulate in the blood, but preferably are deposited outside the blood-vessels, where they may form mycelial masses.

They never penetrate into the substances of the epithelial cells, but go between them (Klebs and Eppinger). They afford a distinction between diphtheritic and inflammatory croup.

M. CH. TALAMON describes a fungus as the true diphtheritic poison, which has a remarkable resemblance to a penicillum. We quote from a translation in the *Chicago Medical Examiner*. He says he has cultivated it in damp cells, and that after its evolution is completed, it appears under the shape of mycelia and characteristic spores. These mycelia sometimes appear as long tubes, partitioned from distance to distance, specially refracting the light, and generally very clear; they are from 2 to 4 and 5 thousandths of a millimeter wide (.000002 to 000005). When the fluids are well conditioned they stretch extremely, at times branch off, and these divisions are themselves peculiar; they form by their slightly incurved branches a figure best compared to a lyre or a tuning fork. At other times, the mycelia do not stretch in this way, although multiplying so as to rapidly cover the surface of the liquid of cultivation, they remain short, take on odd shapes, the most common of which resemble a crutch; there is always present then a multitude of straight cylinders, 4 or 5 thousandths of a millimeter wide by 15, 20, or 40 thousandths long (.000004 m by .00005 m or (.00004m.)

There are two kinds of spores—round or oval—which may be considered the spores of germination, and rectangular spores which represent the last phase of growth of the fungus, and which we will call conidia (conidies). These give the species its particular character; their shape is rectangular and their size very liable to vary; their width varies from m. .000005 to 000015. Sometimes they are isolated, other times they are in groups of 2 or 3: often they form beads of 10, 12 or 15 individuals, or a small chain in zigzag. Homogeneous at first, they soon become filled with small, round bodies, very brilliant, the size of common micrococci, which appear to me as the true germ of the fungus.

The round or oval spores form the mycelium by stretching; they look like bright specks m. .000003 to .00005 in diameter, in the middle of granular matter, spread in sheets of greater or lesser extent, which represent what is called zooglea. The spores stretch one of their poles so as to form a tube m. .000002 to 000004 in diameter, which branches as above stated. When the lengthening of the mycelium is first begun, the space with its prolongation represents a tadpole. Mr. TALAMON claims to have produced diphtheria in rabbits, guinea pigs, cocks, and pigeons, by inoculating with this fungus, and even some frogs who were fed upon the fungus promptly succumbed to the disease.

(B.) AGAINST A FUNGOID ORIGIN OF DIPHTHERIA.

SENATOR (*Berliner Klin. Wochenschrift*, 1872, No. 26, 27, 31, and 33, and *Volkmann's Sammlung Klin. Vorträge* 1874, No. 78) declares himself decidedly against a fungoid origin of diphtheria, on the following grounds:

Other diseases of the mouth and the pharynx are accompanied by the same micrococci, which are also found in the mucus between the teeth and in the urine of the normal man, micrococci being only the spores of leptothrix buccalis. The diphtheritic micrococci do not differ in cultures in any way from those of other origin.

Experimental proof.—Inoculations with any putrefying substances have given the same local and secondary changes as those produced by true diphtheritic material.

Scarlet fever produces precisely identical local lesions in pharynx as those which occur in diphtheria.

Micrococci multiply enormously on account of the favorable conditions in the pharynx created by the deep-seated ulceration: when ulceration is absent, as in the larynx the micrococci are in only very moderate number; probably the carbonic acid is exerting also some antiseptic effect in the latter case.

BILLROTH (*Untersuchungen uber Vegetationsformen der Cocco-bacteria Septica, &c.*, Berlin, 1874), who investigated the bacteria question exhaustively, came to the conclusion that they are only concomitant with diseases, and expresses himself positively against the view that the different affections are caused each by special forms of bacteria. He says that the so-called pathogenic bacteria of diseases are positively identical with those found in putrefying dead tissues.

LEBERT (*Ziemssens Handbuch der acuten Infectionskrankheiten* vol. I, p. 255) is also against the fungoid theory, on the ground that nothing has yet been proven.

WAGNER thinks there is a great difference between the human pseudo-membrane and the experimentally-produced false membrane.

BEALE (Disease d germs, London, 1872) denies specific fungi altogether.

NAGELI thinks that all varieties of bacteria are derivatives of one and the same species of fungi.

Dr. JACOBI, of New York, also entirely dissents from the fungal origin of diphtheria.

Dr. C. HARLEY (Pathol. Transact., vol. x, p. 315) failed to inoculate animals with diphtheritic membrane.

In a very able study of the subject Drs. SATTERTHWAITE and CURTIS (Report of Dr. Edw. Curtis and Thos. Satterthwaite to the New York City board of health, New York, 1877) are also opposed to the fungal theory, on account of the following facts and deductions, founded upon their own researches.

First. The bacteria of diphtheritic membranes do not differ in optical or chemical behavior from those found in putrescent but non-diphtheritic animal material.

Second. They believe the disease produced in rabbits by diphtheritic inoculation is not diphtheria, and find that "Scrapings from the upper surface of a somewhat furred tongue from a healthy person" produce, when placed in the cellular tissue of the rabbit, symptoms and results exactly similar to those caused by inoculations with diphtheritic membrane; also that inoculations of rabbits with putrid Cohn's fluid produce similar results to those.

Third. Salicylic acid added to the diphtheritic matter does not prevent its action, although, as they believe, it acts fatally upon the germs.

[This last objection is not, as it seems, a conclusive reason, for it is very possible that salicylic acid may arrest the growth of micrococci without killing them. In the experiments of Curtis and Satterthwaite, it was shown that before the injection the micrococci did not grow in the presence of the salicylic acid; after the injection the salicylic acid is undoubted removed from the injected material by being absorbed into the system, the micrococci remaining largely at the seat of inoculation. Under these circumstances if the micrococci were only benumbed not killed by the acid, they would of course soon begin to grow and assert themselves.]

CHAPTER II.

STUDIES UPON THE HUMAN SUBJECT.

In the introductory summary we have given an epitome of the results obtained by all of the investigators as to the relations of bacteria to diphtheria, with whose work we are familiar. In the following pages we will confine ourselves more or less closely to our own studies. These have been made from a double point of view, namely, clinical and experimental. The first question which naturally presents itself is, are the bacteria, which are always present in the false membrane of diphtheria, identical in form and size with those which are present not only in the membrane of a non-diphtheritic trachitis, but also in the exudation of an inflamed tonsil? We do not hesitate in affirming that it is not possible to determine, even with the highest powers of the microscope, whether an individual micrococci colony or a mass of such colonies have come from the surface of a furred tongue or from an ordinary case of simple throat inflammation, or from one of a diphtheritic character. As evidence of this we offer the following microphotographs, one taken from an undoubted case of diphtheria, the other from an inflamed throat.

A second question, no less important than that just discussed is, are bacteria always present in diphtheria, or only in some cases? The vital nature of this query scarcely requires pointing out; if bacteria are really always to be found in the disease it is very probable that they are at least an essential part of it; on the other hand, if they are only occasionally present it is most probable that they are an accident of the affection.

In attempting to answer the question just propounded we have examined a large number of cases. Without further discussion, we desire once for all to state that every precaution has been taken to make the examinations at once careful and exhaustive.

The cases examined are naturally divided into two sets, according to their geographical and epidemic relations: one of these sets (No. 1) represents what we may be allowed to call endemic or sporadic diphtheria: the other series (No. 2) illustrates true malignant epidemic diphtheria. In the city of Philadelphia there are always more or less numerous cases of the disease of varying type as to severity, but at no

time during our studies has there been anything which could properly be termed an epidemic of diphtheria. Cases of set No. 1 were all observed in Philadelphia or its vicinity.

The town of Ludington, situated on Pere Marquette Lake upon the east shore of Lake Michigan, in the State of Michigan, is a center for the lumber trade, and an enormous amount of sawdust is annually produced there. A part of the town is situated upon a high plateau, but the third ward, bordering upon the lake, is built upon a swamp, which has been filled largely with the great staple of the place, *i. e.*, sawdust. The drainage is so bad that in many places a hole dug a couple of feet in the ground soon fills with water, and only in a small percentage of the houses has any attempt been made to construct cellars. During the winter of 1880 and 1881 diphtheria appeared in this low region and spread with such thoroughness that it is said scarcely a child escaped an attack, and about one-third of them died. Dr. Formad was sent in the month of June to Ludington and made studies there of the disease, with especial reference to the micrococcus question. The cases there studied constitute set No. 2, and may be fairly considered to represent the most malignant form of the disease.

Set No. 1.

Case I.—Boy, three years old, under the care of Dr. Schrotz. He took the disease simultaneously with two other children, and died on the fifth day, chiefly from asphyxia. The membrane appeared first in the pharynx.

Autopsy.—Blood taken by sealed glass tubes* from jugular vein eighteen hours after death contained micrococci; organs not examined; false membrane from larynx used for culture.

Case II (Dr. Campbell).—Girl, eighteen years old, with profuse exudation on tonsils and pharynx and extending into nasal cavity. Blood from finger did not contain micrococci.

Case III (Drs. Griffith, Middleton, and Zerns).—Boy, six years old, took the disease June 26. Exudation first appeared in the pharynx and afterwards extended into the larynx. Blood examined July 1 and July 2, and at 10 a. m. July 4. Contained no micrococci. The last examination was made by both of us, conjointly. Child died 12 noon July 4. The cause of death was suffocation from stenosis of the larynx.

Autopsy, thirty hours after death.—Blood taken from jugular by means of sealed tubes contained micrococci, both in masses and attacking the white blood cells.

Rigor mortis not marked; no signs of decomposition. Face and neck were of dark blueish hue. All the veins of the neck were enormously distended by very dark blood. Salivary and cervical lymphatic glands strongly congested and somewhat enlarged. Larynx and trachea were almost completely obstructed by moulds of false membrane, the latter extending into many of the bronchi. The mucous membrane of the upper anterior portion of trachea showed several shallow necrotic ulcerations. The vocal cords were thickly covered with closely adherent pseudo-membrane. Lungs congested and œdematous; several hemorrhagic infarctions at the periphery of lower lobes. Pericardium and pleura congested. Heart: right side filled with large ante-mortem clots, extending into pulmonary artery and its ramifications. Orifices and endocardium normal. Liver, kidneys, and spleen strongly congested; microscopic examination did not show any other lesion than cloudy swelling, and proved *absence of micrococci*. Stomach empty, and, like the intestines, was much distended by gases, and the mucous membrane of both congested. Other abdominal viscera normal. Examination of tongue, pharynx, and brain was not permitted.

Case IV (Dr. Gibbs).—Boy, eleven months old, admitted to the Philadelphia Hospital, July 7, with considerable membrane in the pharynx, and marked febrile disturbance. The blood showed abundant micrococci in large vesicles, about twice the size of white blood corpuscles, out of which they were apparently formed.

July 8.—Blood showing similar appearances as on the 7th.

July 11.—Child much better. Blood containing few micrococci.

July 13.—Child well. Blood showing no signs of micrococci.

Cases V, VI, VII.—Respectively, boy three years old, boy five years old, and girl seven years old, treated at Philadelphia Hospital. The symptoms were abundant false membrane in the pharynx, not extending into trachea, with prostration and fever. All recovered. The blood of each was examined twice but no micrococci were found.

Case VIII.—Boy, nine years old. The membrane in pharynx was slight, but in the larynx and trachea profuse. The child died, on the eighth day of the disease, of asphyxia from laryngeal stenosis. The blood examined twenty-four hours before death contained no micrococci. No autopsy was allowed.

Set No. 2.—(Ludington Cases.)

Case I.—Boy, five years old, no strong constitution, died of prostration on the fifth day of the disease, at which time the false membrane, which at first was profuse, had lessened very much, so that there was no serious mechanical obstruction to respiration. Suppression of urine came on thirty-six hours before death. The blood examined during the second day of the disease showed micrococci in moderate quantity; a few attacking white blood corpuscles. Third day of disease micrococci in the blood much more abundant, very many of the white corpuscles attacked by them. Fourth day, masses of micrococci free in the blood, the white corpuscles almost all affected. Fifth day, blood very dark in appearance, clotting very rapidly, full of micrococci, no white corpuscles free from the fungus. Half an hour before death blood was taken from the finger (which was very cold); it was very dark, coagulated almost instantly, and offered but few micrococci. It was then taken from the thigh, where the temperature was still high, and was found to be gorged with micrococci.

Autopsy twelve hours after death.—

Body of livid appearance; no rigor mortis; no fœtid odor; no signs of decomposition. *Brain:* Sinuses filled with very dark blood containing enormous quantity of micrococci. (It was taken by sealed glass tubes before opening of vessel.) All the blood vessels of the brain and its membranes congested; other changes were not notable by naked eye nor by microscope. There was some increase of fluid in the lateral ventricles. The medulla oblongata and a small portion of the cord which was removed through the occipital foramen did not show any morbid changes. *Neck:* Lymphatic and salivary glands enlarged and highly congested. All the large veins highly distended. Blood similar to that found in sinuses of brain. *Tongue* removed from below, intact with the *tonsils, pharynx, larynx,* and *trachea.* The mucous membrane of all these parts was covered with moderate-sized patches of pseudo-membrane which, in some places, appeared raised over the surface, in others, showing shallow necrotic ulcerations. The same was observed upon the vocal cords and the nasal mucous membrane. In the trachea the exudation was slight, most marked at the bifurcation, and of darker color than in other parts. *Lungs:* Congested with slight hemorrhagic infarctions in lower lobes; a few of the bronchi contained casts of the exudate. *Heart:* Pericardial fluid increased; heart muscle congested; otherwise normal; right side contained large, white, firm clots extending into pulmonary vessels; in left side only red clotted blood. Mycotic erosions were seen upon endocardium below the pulmonary and the aortic valves. Mediastinal and bronchial glands were enlarged and congested. *Liver* enlarged and extremely congested; gall bladder very much distended with very dark bile. *Spleen* normal size, rather hard in consistency, and showing congestion and hemorrhages. *Stomach* showed a few hemorrhagic erosions, and contained only a few drachms of a dark semi-liquid matter. The intestines, although of dark hue, appeared normal. *Kidneys* enlarged, strongly congested, and presented the appearance of acute parenchymatous nephritis. This was confirmed by microscopic examination, which revealed, also, micrococcus emboli in the blood vessels of these organs. The bone marrow, taken from a rib, as well as the parenchyma of the spleen, was infested by micrococci. Rest of organs normal. The urinary bladder was found empty.

Case II.—Girl, two years old, attacked June 14 and died on the 24th. Her condition had varied much from day to day. The blood was examined daily for micrococci, which were always found, but their numbers seemed in direct proportion to the severity of the constitutional symptoms; when the child was worse the micrococci were very abundant.

Case III.—Boy, seven years old; recovered. The blood was examined on three successive days of the disease and micrococci found.

Case IV.—Girl, three years old. The blood examined on the fifth day of disease was found to contain micrococci.

Case V.—Boy, four years old. Disease mild. The blood examined the third and fourth days of disease was found to contain a few micrococci.

Case VI.—Girl, four years old; mild form of disease. The blood was not examined until the eighth day of disease, when the child seemed nearly well, and no micrococci were found.

Case VII.—Girl, eleven years old, mild form of disease. The blood was examined once and no micrococci found.

Case VIII.—Boy, five years old; grave form of disease. The blood was examined on the fifth and sixth day, and found to contain micrococci.

Cases IX, X, XI, XII.—Four children, between three and twelve years old, in one family. All had the mild form of disease; the blood of each was examined once and no micrococci found.

Case XIII.—Girl, four years old; recovering from severe attack and still much affected. The blood contained micrococci.

Cases XIV, XV.—Girl, seven years old; boy, nine years old. Both were convalescing from mild form of disease and the blood contained no micrococci.

The records of the cases just detailed show that in Series No. 1, out of seven cases in which the blood was examined *during life* for micrococci, in six (Cases II, III, V, VI, VII, VIII) no fungi were found, whilst in one case (*IV*) micrococci were somewhat abundant in the vital fluid. These cases, it must be borne in mind, represent the endemic mild diphtheria as seen in Philadelphia. The Ludington cases representing the severe epidemic form of the disease were fourteen in number. In seven of these (Cases I, II, III, IV, V, VIII, XIII)

*A small glass tube closed at one end was drawn to a point hermetically closed whilst hot. The sharp point thrust into the jugular vein was broken off and blood drawn up into the tube.

micrococci were found, and in seven (Cases VI, VII, X, XI, XII, XIV, XV) none were present. The cases in which there were no micocrocci were all of them very light, or in the stage of convalescence, and the amount of the fungi present in the malignant cases seemed to be proportionate to the severity of the symptoms, and to steadily progress with the disease in the fatal cases.

The study of these two sets of cases is sufficient to enable us to formulate, as established, the proposition that in *endemic mild diphtheria, micrococci are always present in the part locally diseased*, but are *usually not present during life in the blood or in the glandular organs, even in cases which prove fatal; that in malignant epidemic diphtheria micrococci are always, present in the part locally diseased, and are also usually, and perhaps always to be found in the blood and tissues of severe cases, but are frequently, if not usually, absent from the blood of mild cases.*

At first thought this proposition would seem to prove that bacteria are not an essential but an accidental phenomenon of diphtheria. We think, however, that this is hardly a warranted deduction. The micrococci are *always* present in the throat, and in the fatal cases of endemic diphtheria noted the death was seemingly produced by the local disease, rather than by the infection of the general system. It will almost certainly be found that where endemic diphtheria kills by affecting the general system, micrococci are to be discovered in the blood. Again, if the bacteria obtain entrance through the throat, it is conceivable that they may enter through the lymphatics, and may exist in the interior of the body to some extent before they find their way into the blood in sufficient numbers to make themselves apparent to the microscopist. Confirmatory of this is the circumstance that in Case III, although no micrococci were found in the blood during life, they were present in the fluid in great numbers thirty hours after death. Under these circumstances it is very important to know whether the lymphatics and the blood-making organs are the primary seats of infection or not. We are unable to present clinical evidence upon this point, but desire to call the attention of investigators to the matter, and may state that in animals we have found the spleen and bone marrow especially attacked by the fungus.

The next question which offers itself is, are micrococci found in the blood in other diseases besides diphtheria; and, if so, are such micrococci distinguishable from those found in diphtheritic patients? On this point we have not facts sufficient to warrant positive conclusions. Micrococci must, however, be considered as very rarely present in human blood, for we have made a large number of examinations of blood taken from persons suffering from various diseases and have only found them in three cases other than diptheria. These cases are as follows:

SET No. 3.

CASE XVI.—A woman in the lying-in wards of Philadelphia Hospital; blood examined twice during life; both times micrococci not to be distinguished from those of diphtheria were found in the blood. The patient died, but no autopsy was allowed.

CASE XVII.—Girl, eighteen years old, in the wards of the Philadelphia Hospital, suffering from scarlet fever with very severe angina, the throat being full of exudation. Blood examined three times, full of micrococci, whose abundance progressively increased, and on the morning of her death the blood was loaded with them.

CASE XVIII.—A male English emigrant, about twenty-one years of age, in the wards of the Philadelphia Hospital, suffering from very pronounced typical scarlet fever, with intense angina. Blood examined a few hours before death full of micrococci, exactly resembling in their form and position those of diphtheria. *Autopsy*, Twelve hours after death revealed an acute parenchymatous nephritis without micrococci emboli and intense congestion of the organs.

If it were established that in various septic diseases micrococci of similar forms are found, this would not show that the micrococci are not the cause of the disease; for on the one hand it may be that the peculiarities of the various affections are due to peculiar local conditions and that the constitutional symptoms, which are always much alike, are the expression of a common septicæmia; and, on the other hand, it is also possible that micrococci, which look alike, are really diverse entities.

On closer examination, however, it will be seen that our studies have failed to show positively that micrococci similar to those of diphtheria are present in other diseases. In our first case it is entirely uncertain as to what disease the woman had. She may have been suffering from a diphtheritic infection of the genital organs; and in the two other cases the patients had throat lesions in no way distinguishable from those of common diphtheria; indeed, no less a pathologist than Professor Wagner asserts that the condition in which they were is a form of diphtheria, and describes it under the name of scarlatinal diphtheritis.

In conclusion, it seems to us that our clinical studies do not *prove* that in diphtheria the micrococci are not the cause of the disease, but simply flourish because the disease produces conditions that favor their growth. All the known facts in regard to the clinical history and pathology of diphtheria are capable of explanation upon the theory of the fungal origin of the disease; but they certainly do not establish the truth of such theory. It is to us evident that the relations of micrococci to diphtheria can only be successfully elucidated by experimental inquiry, and that such inquiry must have two directions; first, a study of the life history of the micrococci; second, an experimental investigation as to their power of producing the disease in the lower animals. In the following chapters are given the results we have reached whilst endeavoring to proceed along both these lines of research.

CHAPTER III.

PATHOLOGY OF DIPHTHERIA.

Under this heading we will give the results of our studies of autopsies, the microscopic examination of organs and a detailed account of our culture experiments of bacteria.

PATHOLOGICAL ANATOMY.

Diphtheria and pseudo-membranous croup are considered totally distinct diseases by the majority of clinicians. Some admit a diphtheritic croup, which is to be distinguished from an inflammatory croup.

The results of experiments (which will be detailed in another chapter) and careful studies of the anatomy of the lesion do not justify the above distinction. It will be shown that the morbid process which gives rise to the respective lesions in the pharynx and in the air passages is the same, and the anatomy of the products identical.

It is easy to demonstrate that the apparent difference in the lesions of diphtheria and pseudo-membranous croup, and in the morphology of the exudates is altogether conditioned by and dependent upon the anatomical peculiarities of the pharynx and respiratory passages; and more so yet by the degree of affection.

The submucous tissue of the pharynx is made up of a loose, highly vascular connective tissue which does not restrict the congestion of the vessels and the extravasation of the corpuscular elements. At the same time, however, the rapidly coagulable exudate only partly reaches the surface of the mucous membrane, the bulk of it being kept below by the heavy layer of stratified epithelium.

The submucous tissue of the trachea, on the other hand, is made up of a dense, elastic tissue and a less vascular tissue, backed by the avascular cartilagenous rings. Hyperæmia and extravasations from the vessels are here limited and only severe inflammation will give rise to exudates which are rapidly expelled to the surface by the dense matrix, and meeting with no resistance on the part of the single-layered epithelial covering, coagulate mostly on the surface. Again, the mucous membrane of the fauces and mouth has a squamous not easily detached epithelium, and consequently membrane connected with or springing from such surface is firmly adherent. The epithelium of the trachea is columnar, ciliated, and detaches with the utmost facility even in normal conditions of the organ; hence membrane attached to it separates readily. The membrane of diphtheritic trachitis is always readily detached in the line of the epithelium.

This detachment is, according to Rindfleisch, further facilitated by the excessive secretion of the tracheal glands, the liquid forcing itself between the mucous surface and the pseudo-membrane.

We also observed that the exudation on the trachea, even in the simplest inflammatory croup, is met with not only on top of the epithelium, but also below the latter, precisely as in true diphtheritic angina, only in slighter degree.

Our preparations show that the exudation of the croupous inflammation excited artificially in the trachea (see chapter iv), is not merely superficial, but also extends below the basement membrane, as illustrated in the accompanying cut.

In cases of artificial croup as well as in those observed in man, in which the *submucous* infiltration is prominent, we have seen loss of substance, viz, necrotic ulcerations similar to those occurring in genuine diphtheritic angina.

Another distinguishing point made by authors between the pharyngeal and tracheal lesions in question is the independence of their individual occurrence, it being asserted that, if a real malignant diphtheritic trachitis occurs, it is only by extension from the pharynx downwards into the air passages. It is true that diphtheria usually begins in the fauces, but we have observed in several instances the reverse to have taken place; and in two of our rabbits in which an artificial pseudo-membranous trachitis was induced the disease extended also upwards, producing a secondary most violent pseudo-membranous angina. Finally, as the most important difference between diphtheritic and inflammatory croup and between diphtheria and true croup some authorities insist upon the presence of micrococci in one and their absence in the other affection. In a later chapter we will prove that this assertion is untenable.

The frequent absence of the systemic disturbances in the local affections of the air passages can likewise also be explained by the anatomical peculiarity of the trachea and larynx; the dense unyielding subcutaneous and cartilageous tissues of these parts, their deficiency in blood vessels and imperfect connection with the lymphatic apparatus prevents in a great measure the absortion into the system of the necrotic products, so that either recovery or death from stenosis takes place before a possible systemic infection ensues.

We are not ready yet to report in extenso on the general pathological anatomy of diphtheria in man, as our investigation in this direction is not completed. Owing to paucity of time our attention was mainly taken up by experiments upon animals and the study of the natural history of the contagium. Human as well as comparative pathologo-anatomical studies should be continued and carried out exhaustively. Our opportunities for autopsies in man were limited to two cases of diphtheria, viz, one of each of the sporadic and epidemic forms. The results of these are given in chapter II (see case III, of Set 1, and case I, of Set 2). The lesions in animals are described in the tables of experiments in chapter IV.

We next will enter upon our studies of the bacteria so closely associated with the question of diphtheria.

MICROCOCCI.

I.—MORPHOLOGY.

A.—Recognition of micrococci.

Great difficulty is sometimes encountered in distinguishing bacteria from other minute organic and inorganic particles. Certain mycelial threads and vibrios, coagulated fibrin, and protoplasmic and fat molecules often closely resemble micrococci.

As this is a question of importance we will briefly enumerate the various methods which we have employed and found serviceable in the recognition of micrococci.

In zooglea forms the micrococci can be distinguished at one glance by an experienced eye, as the micrococci of an individual zooglea mass are always uniformly of one size and are always at the same distance from one another, in contradistinction to albuminous and fat molecules, which vary in size and are at varying distances from one another.

Isolated micrococci may vary in size, as may also the micrococci in the different zooglea groups, some of the latter being made up of smaller and others of larger micrococci.

Micrococci may arrange themselves in pairs and in chains; non-living molecules or granules cannot.

Micrococci are not soluble in strong acids and alkalies, nor in alcohol and ether, as are fat and most other molecules.

a. Superficial pseudo-membrane. *b.* Croupous exudate below basement membrane. Between *a* and *b* are seen some remains of surface epithelium. *c.* Ecchymosis in submucous tissue and infiltration of tracheal glands with blood corpuscles. *d.* Cartilage. *e.* Outer connecting tissue and muscular investment.

Micrococci take the staining well, particularly with hæmotoxylin and aniline dyes, and the aniline dye cannot so easily be washed out as in the case of animal tissues. For this reason sections of tissues may readily be prepared in which only the bacteria are stained. Beautiful preparations may also be made by simply treating sections which a mixture of glycerine and acetic acid; the micrococci in such preparations become yellowish brown and prominent amid the perfectly translucent structures.

Tincture of iodine has proved in our hands an excellent staining fluid for bacteria within tissues. If a section has been first treated with a solution of caustic potash, iodine stains the micrococci deep yellow, while the rest of the tissue is only slightly tinged.

The most important distinguishing point between micrococci on one hand and organic and inorganic particles on the other hand is obtained by culture. Micrococci will always multiply, though sometimes much more rapidly than others. They elongate, divide, form chains or zooglaea masses if brought into a suitable culture medium.

If the above-mentioned distinctive points are observed, mistakes in recognizing micrococci and other bacteria are entirely out of the question.

In regard to the question of magnifying powers used in recognition of micrococci we can affirm (contrary to statements of some other investigators) that a good one-fifth objective is sufficient for the detection of the diphtheritic micrococci, particularly when appropriate staining is used. We have seen no micrococci with a magnifying power of 1,500 which we could not detect with an amplification of 500 diameters. For the finer morphological details of micrococci a high magnifying power is required, and we have habitually used a one-twelfth Zeiss Homog-Immerson.

We desire also here to state that as the result of much experience we are positive that the excessive precautions often insisted upon by authors as necessary in looking for micrococci in the blood, &c., are not in fact necessary. Micrococci do not exist in the air to any extent, and exposure of blood slides for a few minutes to the air never is followed by the appearance of micrococci, when none have previously existed. This is not true of moving bacteria, which in their early growth we ourselves have in some of our former researches mistaken for micrococci, and which may appear rapidly in exposed blood. In order, however, to disarm criticism we have, in all our blood examinations, used the utmost precautions.

B.—Morphology of the micrococci as observed in cases of epidemic diphtheria, in the local cases of sporadic diphtheria, and in induced diphtheria in animals.

When a diphtheritic false membrane was examined (by teasing it in glycerine or fresh aqueous humor) under the microscope immediately after its removal from the pharynx, or the air passages, there was seen, besides the cellular constituents, only one kind of bacteria, viz, micrococci.

Diphtheritic membrane removed some hours previous to examination or removed post mortem, in addition to micrococci, yielded other forms of bacteria described by authorities. Unless the diphtheritic alteration becomes of gangrenous character, we are not able to detect any other bacteria than micrococci. Eberth, who describes only rod bacteria in diphtheria, or those investigators who describe different varieties and mycelium of bacteria, probably examined only membranes removed some time previously, or such as were removed post mortem.

Our experience with a large number of cases is so absolute that we believe the occurrence of rod bacteria is proof that a membrane has begun to putrefy. It may be that in endemic or mild diphtheria the micrococci have not the power of growth that they have in malignant diphtheria, and that consequently rod bacteria have a better chance to develop than in the membrane of the malignant disease.

The micrococci were in every case of at least two sizes, according to their stage of development, or to earlier or later generation (see culture accounts). The smaller ones mostly infested leucocytes and mucous corpuscles within which they were seen dancing in a trembling motion (the appearance has been well compared with flies caught in a fly-trap.) The larger micrococci were nearly all in zooglaea form, or *infesting and apparently destroying* the epithelial cells. The latter fact is *not* in accordance with the observation of Klebs and Eppinger, who assert that the micrococci in diphtheria never infest the epithelium, but merely penetrate between the cells.

In the blood of patients suffering from the epidemic diphtheria at Ludington, we always found micrococci within the white blood corpuscles (never the red ones), or in zooglea form, or to some extent free, just as they exist in the membrane. Notably the quantity of micrococci was always in direct proportion to the intensity and the stage of the disease, as recorded in the clinical part of this memoir.

C.—Methods and objects of culture.

We have employed two distinct methods of culture. The first is that described by Dr. E. Klein, of London, in his report on infectious pneumo-enteritis, from whose paper the following cut is abstracted:

Fig. I.

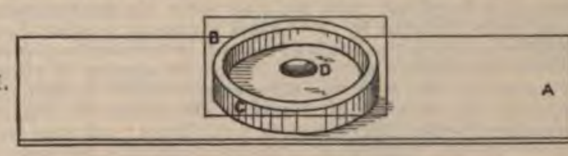

Fig. I represents, of natural size, one of the culture cells.

A is the object-glass; B is the covering-glass, fixed by means of a thin layer of oil upon the upper (polished) surface of the glass ring C, which is cemented on the object-glass. The covering-glass, which

should be as thin as is obtainable, has on its lower surface the droplet D, in which the fungus has been planted. In using this method the minutest speck of the infected material is removed with the point of a clean (previously heated) needle, and placed in a drop of fresh aqueous humor of the eye of a healthy rabbit, or some thoroughly sterilized culture fluid, on a thin square glass-slip. This is inverted and fixed, drop downwards, by means of a thin layer of pure sweet-oil on the glass ring specimens.

The preparation thus mounted was placed in the incubator or oven, where the temperature was automatically maintained at various points, not below 32° and not above 45° C. In most cases we used a temperature of 37° C.

After twenty-four hours the specimen, which we will call the first generation, is used to establish a second generation in a new drop of culture fluid in the following manner: The covering-glass of the above "cell-specimen" is lifted up and, with the aid of a fine capillary tube, a minutest quantity is removed from the edge of the droplet. In the accompanying Figure II this capillary tube is portrayed in its natural size; the contents of the tube between *a* and *b* represent about the quantity that is removed from the drop D of the previous specimen. The capillary tube is then filled with culture fluid up to about the mark *c*. A new clean covering-glass is taken; on its center is deposited a droplet of fluid from our capillary tube, and the covering-glass is then inverted and fixed with a thin layer of oil on the glass ring of another "cell." This new preparation, which represents the second generation, is also placed in the incubator and kept there at the above-named temperature for twenty-four hours. After this time it is used to inoculate another "cell-specimen," representing the third generation, and so on, from generation to generation, until the end of the culture.

FIG. II.

The second method employed was that perfected by Dr. Sternberg, which we believe has been already described by him in the publications of the National Board of Health. This plan has the advantage over the method of Klein that the cultures can be made on a larger scale for the purpose of inoculation of animals, but we have found the cell and glass cover more useful in observing the growth and development of the fungus.

The following objects were put in cultivation:

Sporadic diphtheritic pseudo-membrane, fresh and dried.

Epidemic diphtheritic pseudo-membrane, dried only.

Fragments of spleen and kidney from epidemic diphtheria dried.

Pseudo-membrane from artificial croup, produced by ammonia.

Blood from diphtheria.

Blood from septicæmia.

Blood from scarlatina.

Gangrenous matter from foot.

The most extensive and satisfactory cultivations were made with dried diphtheritic matter. The culture experiments with fresh Ludington material were imperfect, as it was impossible for us to carry them on systematically in that town. Perfectly satisfactory results can be expected only when cultures are made in localities where epidemic diphtheria ravages, and the material can be put into culture perfectly fresh.

As a medium for the culture of the diphtheritic fungi the following fluids were used with the best results: bouillon of chicken or rabbit, perfectly sterilized by protracted boiling; ascitic fluid whenever there was opportunity to put it in sealed tubes immediately after tapping; aqueous humor, which is drawn from living animals by a little sharp-pointed pipette, as represented in Figure 11, with great facility. Other culture mediums, such as solution of gelatine, egg albumen, Pasteur's fluid, solution of dextrine, and simple sirup were also tried, but with less satisfactory results.

As control experiments the culture fluids were usually tested by placing sealed cells in the incubator for twenty-four hours, but no organisms developed in successful cells or tubes.

D.—BIOLOGY OF THE DIPHTHERITIC MICROCOCCI AS OBSERVED IN CULTURE.

If a minute particle of fresh diphtheritic matter or some scraping from tongue be put into a drop of pure culture fluid in a cell fixed in a manner as described, there are seen under the microscope a few epithelial scales infested by micrococci averaging in size $\frac{1}{28000}$, but sometimes reaching a maximum of $\frac{1}{14000}$ of an inch, and a few leucocytes filled with minute micrococci, which on account of their extremely small size and their trembling motion within the cell cannot be measured; the surrounding liquid is clear, and will remain so for from six to twelve hours if kept in a cold room; but after having been placed for one single hour in the incubator at a temperature of 40° C., slight clouds appear around the particles in the droplet.

Observed under the microscope and watched for a few hours, the micrococci are seen to undergo the following changes:

The micrococci contained in the leucocyte after a period of slight but very active movement, during which they look as if they were eating up their foster nurse pass into a quiet state. They now completely fill the corpuscle, which appears to burst, and the whole internal mass escapes as an irregular glass-like body full of quiet uniform micrococci of about $\frac{1}{30000}$ of an inch in diameter, the whole constituting the so-called "zooglaea masses." Often the collapsed vesicle was seen lying alongside of such a mass just escaped from it.

The finer micrococci and those infesting the epithelial cells have grown larger and acquired a yellowish-green color. Some of them can always be seen to be undergoing the process of division, which is better studied, however, a little later.

After twenty-four hours the zooglea masses can be seen to be breaking up and setting free small individual micrococci. The larger micrococci have in the meanwhile elongated; some of them resemble in appearance short rod bacteria, whilst others of them are constricted in the middle like the figure 8. The latter forms have a peculiar trembling motion as if they were making an effort to separate the two parts. Except in the case of the peculiar vibration already noted inside of the leucocytes and this trembling before division, we have found the micrococci always motionless.

The aureole of mucous substance surrounding the isolated micrococci, particularly well described by Pasteur and Sternberg, is well marked at this stage. In color the larger micrococci are somewhat greenish-yellow, while the smaller ones are colorless.

After the lapse of forty-eight hours multiplication is seen to have continued, and to be occurring in micrococci originally derived from the balls. A large number of micrococci are observed elongated or in pairs, and also a few are arranged in fours so as to resemble a sarcina, and in chains. After this no further multiplication will occur, unless new culture pabulum is added. In a second generation the multiplication will proceed in a very vigorous manner so that within twenty-four to forty-eight hours a fresh droplet of culture fluid to which only a few micrococci have been added on a pin is completely filled out with millions of mostly round micrococci. The different forms of grouping are best expressed on the second and third day of culture. Vigorous multiplication continues also in the third and fourth generation and occasionally in the fifth, but in later generations up to the eighth the rapidity of multiplication gradually subsides and is hardly perceptible in a ninth or tenth generation. It is said by some authorities that micrococci kept for a while in a culture tube will diminish in quantity and even disappear; we cannot affirm this from our own experiments. Micrococci may cease to multiply, but in many instances a diminution in quantity had not been perceptible even after the lapse of months.

The above history refers to micrococci from true malignant diphtheria; in the case of cultures of tongue-scrapings the micrococci ceased to multiply as early as the third generation, and frequently in the second generation their growth was very slow. In addition, in tongue-scraping, some leptothrix threads frequently accompanied the micrococci in the first and second culture, and, as well as in diphtheritic culture, bacterium termo made occasionally its appearance in early generations, but *it promptly disappeared if the temperature in the incubator went for a while to* 40° and did not afterwards sink below 35°. Later generations in successful cultivation remained always clean in well-regulated temperatures and never showed any kind of mycelial fungi. Cultures with sporadic Philadelphia diphtheria gave results very similar to those achieved with tongue-scrapings; the micrococci possessed some, but not very much more vitality or proliferating power, their growth usually ceasing in the fourth generation.

In regard to temperature we can affirm from our own culture experiments the following interesting facts with special reference to diphtheritic micrococci.

The micrococci multiply best at from 37° to 40° C.; higher temperatures up to 70° C. do not destroy them but only partly arrest their multiplication, which returns, however, if the 70° is again reduced to 40° or 35°.

Fungi other than micrococci, if met with as an admixture in our culture, perished at a temperature above 50°, and proliferated well only at 30° C. and below. Too low temperature frequently spoiled our cultures, for if any spores of rod bacteria were present they usually developed and displaced the micrococci. In high temperatures, however, the micrococci are stronger and displace easily the several kinds of bacteria we observed in impure cultures.

The diphtheritic micrococci do not seem to need a large supply of oxygen for their growth; they even appear to multiply better when distant from surfaces in contradistinction from the bacteria of putrefaction.

In culture tubes the diphtheritic micrococci are always seen as a precipitate. If there is any mycoderma at the surface it is always a sign that the culture is impure, as the bacteria found on the upper surface are always rod bacteria and bacilli, with very few micrococci. This property renders them especially fitted to flourish in dense membrane and in deep tissue where the supply of oxygen must be very small.

In the following tables are given, in sufficient detail, the several series of cultivations which we have made.

II.—CULTURE EXPERIMENTS.

FIRST SERIES.

Diphtheritic false membrane from the cases of Dr. H. Allport, Philipsburg, Pa., probably malignant diphtheria.—Twenty cultures were made being carried on only to third generation. The course and the results of the individual cultures, with the exception of a few failures, were so uniform that the whole series may be recorded in one table.

Culture experiment, representing No. 1 to 20.

MICROCOCCI.—[Matter used: fresh diphtheritic pseudo-membrane. Case of Dr. Allport.]

Date.	No. of generations.	Culture fluid.	Mode of culture.	Temperature in incubator.	Mycoderma or precipitate in tube.	Size of.	Quantity and rate of multiplication.	Mode of grouping.				
								Isolated.	In pairs.	Sarcina form.	Torula chains.	Zooglaea.
During Apr. and May, 1881.	First	Aqueous humour of rabbit.	Cells.	35° to 40° C.	....	$\frac{1}{30000}$ to $\frac{1}{14000}$ of an inch.	At first slow then rapid.	Many.	Few ..	Few ..	Few ..	Many.
	Second	....do	....do	....do	....	....Do..........	Rapid..................	...do ..	Many.	...do ..	...do ..	...do
	Third........	....do	....do	....do	....	....Do..........	Very rapid............	...do ..	...do ..	...do ..	Many.	...do

Many micrococci were in large clouds without any special form of grouping.

All the cultures of this series yielded crops of pure micrococci. No other bacteria interfered in successful tubes. Mycelial fungi were never observed.

SECOND SERIES.

Endemic diphtheritic matter obtained from time to time in Philadelphia.—Twenty-five cultures were made and all the mentioned culture fluids were tried in this series up to a fourth generation. The comparative values of the culture fluids were referred to before.

The general results of the culture experiment were similar to those of the first series up to the second generation. In the third generation the micrococci already began to fail in growth and multiplication, and the fourth generation yielded a still poorer crop. The cultures were occasionally impure—the rod bacteria supervened.

The regulation of the temperature was sometimes defective during the experimentation with this series on account of imperfect working of the mechanism of the incubator. Sometimes the temperature fell down to 20° during the night, and it was frequently observed that rod bacteria made promptly their appearance in largenumbers during such intervals and spoiled the cultures. The same occurred with clean cultures when heat was suspended purposely for several days. Those culture tubes, however, which were subjected to a uniform temperature of not below 37° C. did not show any invasion of rod bacteria, and the growth of micrococci continued in the manner described.

The careful measurement of the micrococci in this series which was best accomplished by measuring the chains of micrococci, revealed a size of $\frac{1}{14000}$ to $\frac{1}{42000}$ of an inch in diameter the latter size relating more to micrococci in zooglea form. The torula chains were usually made up of the smallest micrococci, approaching in this respect to those of the micrococci balls which we have proven to be formed by the invasion of leucocytes by micrococci.

THIRD SERIES.

Thirty cultures were made with matter other than diphtheritic, being carried on to the fourth generation. Although the matter used was of the most diverse character, such as ammonia croup (croupous exudation produced in a trachea of a rabbit by ammonia), slough from gangrene of foot, from septicæmia and scarlatina, yet the results in culture were nearly all identical.

One and the same thing gave at one time an excellent crop of micrococci if temperature of the incubator was kept up high enough and pains were take to keep the culture pure: at another time and with the same culture fluid the same tube showed only a few micrococci, but rod bacteria in abundance, this could be nearly always traced to low and irregular temperature of the incubator. In some cases after the replacing of the micrococci by rod bacteria the tubes were subjected to a high temperature for several days, when the bacteria disappeared whilst the micrococci did not reappear, so that the liquid was left clear. But even in successful cultures the growth and multiplication of micrococci were observed to be prosperous only to the second or very rarely to the third generation. In later generation the fungi grew scantily.

In size, shape, and color, as well as in the mode of grouping, the micrococci were the same as those from the diphtheritic pseudo-membrane. If this was not the case in one generation it invariably was so in the next.

FOURTH SERIES.

Twenty-five cultures were made with epidemic diphtheritic matter from Ludington, and were carried on to the fifth generation. The results were identical in every one of the successful cultures, and the record of one experiment holds good for all the rest.

Neither rod-bacteria nor mycelium could be detected at any time of culture. One of the culture tubes did not show any change in appearance when examined two months later, it having been kept during the whole time in the incubator.

Culture experiment, representing No. 76 to 100.

MICROCOCCI.—[Matter used: dried diphtheritic membrane. Case of Dr. Shorts, Ludington.]

Date.	No. of generation.	Culture fluid.	Mode of culture.	Temperature in incubator.	Mycoderma or precipitate in tube.	Size of.	Quantity and rate of multiplication.	Mode of grouping.				
								Isolated.	In pairs.	Sarcina form.	Torula chains.	Zooglaea.
During July, 1881.	First	Bouillon or ascitic fluid.	Cell and tube.	37° C.	Precipitate.	$\frac{1}{35000}$ to $\frac{1}{14000}$	Slow; twelve hours later slow but marked.	Few.	None.	None.	None.	Moderate quantity.
	Second, next day.	....do	....do	39..	do.	do	Faster; ten hours later; rapid.	Many.	Many.	Some.	None.	Large quantity.
	Third, third day.	....do	....do	38..	do.	do	Rapid................	Large quantity in all forms of grouping.				
	Fourth day..	....do	....do	40..	do.	do	Enormous	Cell specimen is so crowded that mode of grouping is indistinguishable.				
	Fourth, fifth day.	....do	....do	39..	do.	do	Rapid................	In all forms.				
	Fifth, seventh day.	....do	....do.	38..	do.	do	Slower................	In all forms mostly torula chains and zooglaea forms of yellowish color.				

FIFTH SERIES.

Forty cultures were made with epidemic diphtheritic false membrane received from Ludington per express, and were carried to the 10th generation. The membrane was in a semi-dry condition and showed under the microscope the following morphological elements: Epithelial scales and leucocytes both infested by clouds of micrococci. The micrococci were of two sizes, larger ones of a greenish color measuring about $\frac{1}{14000}$ of an inch in diameter, and smaller ones not exceeding $\frac{1}{35000}$ of an inch. There were also seen some rod-bacteria and bacilli and also a number of bundles of mycelial threads

First series of experiments.—Inoculation of diphtheritic matter subcutaneously or in the mucous membrane of mouth—Continued.

Number of experiment.	Date of inoculation.	Animal.	Inoculation.	Recovery or death.	Result of post-mortem, and of microscopic examination.	Remarks chiefly upon source of matter employed.
8	Apr. 29	Small rabbit, No. 8	Same as last	Remained well to May 1st, when killed accidentally.		Case III.—From Dr. Cardeza; inoculation made 15 minutes after removal of the membrane from the child's throat. This case was in same family as No. 1, and originated apparently in contagions.
9	Apr. 29	Small rabbit, No. 9	Same as last	Remained well to May 16, when accidentally killed.	Post mortem revealed no lesions	
10	Apr. 29	Albino rabbit, middle sized, No. 10.	Same as last	Remained well.		
11	Apr. 30	Rabbit, No. 3	Reinoculated with diphtheritic matter in mouth and subcutaneously. May 7, inoculated third time.	Remained well up to May 13; found dead May 14.	Small cheesy lump on thigh at the place of inoculation. All organs tubercular, otherwise to the naked eye of normal appearance. No bacteria in organs.	Case IV.—From Dr. James Collins, twelfth day of disease. Matter semi-liquid, mixed with blood. The case afterward died.
12	Apr. 30	Dog, No 1	Inoculated with diptheritic membrane in mouth and thigh.	Remained well.		Same case.
13	Apr. 30	Large cat, No. 1	Inoculated with diphtheritic matter in mouth and subcutaneously on right thigh.	Remained well; a large lump developed in skin at seat of inoculation, which eventually disappeared. No micrococci in blood.		Case IV.—From Dr. Collins. Case recovered.
14	Apr. 30	Rabbit, No. 11, large albino.	Same as last.			
15	Apr. 30	Rabbit, No. 12, large old albino.	Same as last	Remained well.		
16	May 1	Small Rabbit, No. 13.	Same as last	A small cheesy lump developed at seat of inoculation; died May 12.	Slight exudation on the mucous membrane of the larynx and trachea of grayish color, and translucent. Trachea and lungs much congested. All organs tubercular; in the lungs are seen profuse hemorrhagic infarctions, and numerous bacteria. No bacteria in the organs.	Case V.—From Dr. W. S. Stewart. Membrane inoculated fresh on the day of removal.
17	May 1	Large cat, No. 2	Same as former	Remained well; lump developed on side and disappeared within a week, healing perfectly. No micrococci in blood.		Same case.
18	May 1	Small cat, No. 3	Inoculated in mouth	Remained well		Same case.
19	May 1	Dog, No. 2	Inoculated in mouth, pharynx, tonsils, tongue, and also subcutaneously on the side, with fresh diphtheritic matter. The latter also given to the animal mixed with food.	Remained well. Killed June 11	Cheesy lump which had existed for a long while on the side found to have been absorbed; it its place found a hard lump, probably of cicatricial tissue. No lesions perceptible. Blood examined during life did not show any bacteria.	
20	May 4	Small cat, No. 4	Inoculated with dried diphtheritic matter in mouth and subcutaneously.	Remained well. Killed June 12	No lesions found; blood did not contain bacteria.	Case VI.—From Dr. Frank R. Brunner. Membrane removed several days previously from woman of 45 years; apparently much decomposed.
21	May 4	Large rabbit, No. 14.	Same as in last experiment	Remained well. Has large lump at place of skin inoculaton.	No lesions except a large cheesy lump on side. No microscopic examination made.	
22	May 4	Cat, No. 5	Same as last	Remained well. Killed June 12	Large cheesy lump at the place of subcutaneous inoculation; no signs of diphtheritic inflammation; lungs highly congested, the remaining organs all appearing normal to the naked eye; but microscopic examination showed tubercular granulations everywhere; hemorrhagic infarctions in lungs; no bacteria in organs except lungs.	Case VII.—From Dr. Collins.
23	May 7	Large rabbit, No. 15.	Same as last	Remained well up to May 19. Found dead May 20.		
24	May 7	Small rabbit, No. 9.	Reinoculated with fresh diphtheritic matter in mouth and subcutaneously.	Killed accidentally	Post mortem revealed no lesion	See experiment 9.
25	May 7	Small rabbit, No. 3.	Inoculated the third time as before with fresh matter.	Died May 9	A small cheesy lump on thigh at the place of inoculation; all organs tubercular, otherwise to the naked eye of normal appearance; no bacteria in organs.	
26	May 9	Dog, No. 3	Inoculated in mouth and skin with fresh membrane.	Remained well		Case VIII.—From Dr. James Collins.
27	May 9	Small cat, No. 6				
28	May 9	Small cat, No. 7	Same as the last	Remained well. Killed June 12	All had cicatrizing lump at place of skin inoculation; no other lesions detected; no bacteria in blood.	From Dr. James Collins.
29	May 9	Small cat, No. 8				
30	May 11	Goat, No. 1	Inoculated in mouth and subcutaneously with fresh membrane.	Remained well		Case IX.—From Dr. H. C. Wood. Taken from a case the second day of the disease, the attack having been derived by contagion from the cases of Dr. Cardeza.
31	May 11	Cat, No. 9	Similiar inoculation	Remained well.		
32	May 11	Cat, No. 10	Same as before	Found dead June 11	No microscopic examination made.	

There are recorded in the table just given thirty-two experiments, in only six of which the animals died, unless killed accidentally or otherwise. The time between the dates of death and of the last inoculation was, Experiment 4, six days; Experiment 6, seventy hours; Experiment 11, fifteen days; Experiment 16, eleven days; Experiment 23, thirteen days; Experiment 25, two days. The question naturally arises as to whether the few animals in which the inoculation was followed by death died of diphtheria or of some other disease. Of these fatal cases there were only two in which a strong suspicion of septic poison could fairly be entertained; death was too long delayed. In one of these, Experiment 25, the animal died two days after the third inoculation, but it had been first inoculated 52 days previously, and was very tubercular; so that the last inoculation may have had nothing to do with the fatal result. In Experiment 6 no bacteria were found except in the lungs, no false membrane existed anywhere, the lungs were full of hemorrhagic infarctions and the peculiar long-continued convulsions are not a symptom commonly seen in septic diseases of rabbits. There is therefore no proof that the rabbit died of diphtheria or of septic poisoning; it is probable that the wound of the larynx brought about the fatal result.

In only one of the fatal cases were there any exudations

any organ which could give rise to the slightest suspicion that the animal died from diphtheria. In this case, Experiment 16, there was only a catarrhal inflammation of trachea [with an exudation] which presented some of the characteristics of false membrane. In none of these cases were micrococci found in the blood. There is therefore little reason for believing that the rabbits died from diphtheria or even from septic poisoning. Of what, then, did they die?

A study of the post-mortem reports will show that in nearly every case the internal organs were tubercular and in many cases intensely so; also, that tubercular disease was found in the organs of those rabbits which were killed some days after inoculation. It is therefore a very natural belief that in those cases in which death was long delayed it was due to tuberculosis. In order to discover whether the diphtheritic exudation acted specifically in the production of tubercle, or whether it merely set up a local inflammation which formed a focus of infection, we experimented by putting under the skin of rabbits small masses of innocuous foreign matters.

Second series of experiments.—Inoculation of foreign bodies subcutaneously.

Number of experiment.	Date of inoculation.	Animal.	Inoculation.	Recovery or death.	Result of autopsy and microscopic examination.	Remarks.
33	Apr. 19	Small rabbit, No. 16.	A piece of wood, fragment of a match, put below the skin in the posterior part of the neck and the wound closed by a suture.	Wound healed rapidly, but subsequently a small lump of cheesy matter was formed. The animal was feverish for several days. In the lapse of two weeks the lump disappeared, and the animal remained well to date, June 8.	....	The foreign bodies used here have been before the experiments thoroughly washed and cleaned.
34	Apr. 22	Small albino rabbit, No. 17.	Treated similarly...........	Wound healed rapidly, but within a few days a large lump formed; ulceration set in, and cheesy matter protruded from wound; animal became emaciated, feverish. Died May 13.	All organs appeared hyperæmic; liver contains several small abscesses and numerous small nodules, the latter also seen in lung and spleen; lymphatic glands swollen; microscopic examination revealed large collections of tubercle granulations in all organs; the proportion of white blood corpuscle increased; no bacteria in blood.	
35	Apr. 22	Small rabbit, No. 18.	A piece of clean glass put below the skin in the right thigh; wound closed.	Result similar to last, only slower. Died May 20.	Lesions similar to the last but slighter in degree; hemorrhagic infarctions in lungs very marked.	
36	Apr. 25	Large albino rabbit, No. 19.	A piece of glass put deep below the skin in the right thigh; wound closed.	Wound healed at first, then severe ulceration set in, cheesy matter protruding from wound; the latter increased to four times the original size. Died May 10.	No decided lesions to the naked eye; microscopic examination showed all organs to be profusely tubercular; hemorrhagic infarctions in the lungs; echinococci cysts in the liver; no bacteria in the organs.	
37	Apr. 25	Albino rabbit, No. 20.	Treated similarly			
38	Apr. 25	Small rabbit, No. 21.	Treated similarly with a piece of cork.	Wound healed after slight suppuration. Animals remain well.		
39	Apr. 25	Small rabbit, No. 22.	Treated similarly with a small bunch of clean hair.			
40	May 6	Small rabbit, No. 23.	A piece of wood, fragment of a match, put deep below the skin in the right thigh.	Cheesy lump formed rapidly and protruded from wound. Died May 19.	All organs showed masses of tubercle granulations; no other decided lesion; no bacteria in the organs.	
41	May 6	Small rabbit, No. 24.	A piece of wire put below the skin in the left thigh.	Cheesy lump formed; the wire ulcerated away. Died May 15.	Hemorrhagic infarctions in lungs; tubercle granulations everywhere, although not very marked; no bacteria in the organs; none in the blood.	

It will be seen that in five out of nine of these experiments tubercle was found after death; this large proportion apparently demonstrates that a simple local inflammation may in the rabbit act as a source of tubercular infection. Now, when in our first experiments rabbits were inoculated with diphtheritic matter, inflammation was almost always induced at the seat of the lesion, with the formation of large lumps containing cheesy matter. These facts being so, it is a fair deduction that the tubercles were secondary to these inflammatory foci, and were therefore an indirect and not a direct result of the inoculation.

These experiments, although not perhaps as numerous as they ought to be, seem to warrant the deduction that inoculation with materials taken from patients suffering from the endemic mild diphtheria of Philadelphia frequently produces a secondary or indirect tuberculosis in the rabbit, but very rarely if ever causes any disease in the rabbits comparable to diphtheria in man, or even any septic disorder: of course the experiments do not prove that malignant cases of diphtheria may not occur in Philadelphia and have different relations to inoculation.

The method by which Trendelenburg asserts that he succeeded in producing diphtheria in rabbits consists in placing the exudation matter in the trachea. We naturally have suspected that the membrane when placed in the trachea produces simply a trachitis. This suspicion has been strengthened by the observation that acute pseudo-membranous trachitis and angina occur in rabbits. Such an epidemic destroyed, during the winter of 1879, a number of rabbits kept by one of us in a perfectly clean place. The rabbits first showed sickness by refusing food; examination then detected swelling of the tonsils with exudation. There was a high fever with increase of the local symptoms until the animals became entirely unable to swallow. Death occurred in from three to seven days, preceded by great difficulty of breathing and profound exhaustion. False membrane was abundant in the mouth and trachea, and on examination showed all the characteristics of diphtheritic exudation.

In order to determine whether the tracheal inoculation of rabbits with diphtheritic membrane taken from the mild type of the disease will cause pseudo-membranous trachitis, the following experiments were performed:

Third series of experiments.—Inoculation with diphtheritic matter in the trachea.

Number of experiment.	Date of inoculation.	Animal.	Inoculation.	Recovery or death.	Result of autopsy and microscopic examination.	Remarks.
42	May 31	Large albino rabbit, No. 27. Fresh rabbit.	Inoculated with dried diphtheritic matter, mixed with water, in the trachea, from without.	Still alive and well, June 20....	....	Case X.—Of diphtheria, received through Dr. Jaggard, about 24 hours after removal. The membrane dry and hard, apparently in perfect condition.

Third series of experiments.—Inoculation with diphtheritic matter in the trachea—Continued.

Number of experiment.	Date of inoculation.	Animal.	Inoculation.	Recovery or death.	Result of autopsy and microscopic examination.	Remarks.
43	June 1	Albino rabbit, No. 10. See experiment 10.	Same as last	Died June 6, 5 days after inoculation, in convulsions.	External wound had healed perfectly; some ecchymosis noticeable, and the subcutaneous tissue infiltrated and congested. The wound in the trachea did not quite heal; larynx and trachea are congested and covered by a delicate pseudo-membrane, which reaches, near the larynx, a thickness of 1 mm. Microscopically, it appears identical with the natural and with the ammonia false membrane, containing micrococci in large number. No bacteria in blood, none in organs. The organs are tubercular, more especially the liver, where large nodules can be seen, even by the naked eye. No hyperæmia of organs, as in the ammonia specimen.	Same case.
44	June 14	Young albino rabbit, No. 37.	Inoculated with dried diphtheritic matter, mixed with water, in the trachea.	June 18. Evening. Animals apparently well; take food, &c.; breathing not much interfered with. The same evening killed rabbit 37; No. 38 was found dead June 19.	No lesions; no bacteria in blood, which was very carefully examined.	Case II.—Diphtheritic matter taken by Dr. Richard A. Cleeman from throat of patient untouched; inoculation about 36 hours after membrane was taken; it was dried quickly and was in good condition.
45	June 14	Young albino rabbit, No. 38.	Same as last		No lesion; blood not examined	Same as last.

These experiments show that the membrane of endemic diphtheria will produce a pseudo membranous trachitis, and the question arises, is the pseudo-membrane proof of a specific trachitis, or is any trachitis of sufficient intensity accompanied by the formation of a false membrane? To answer this query the following experiments were undertaken.

Fourth series of experiments.—Injection of ammonia into the trachea.

Number of experiment.	Date.	Animal.	Inoculation.	Recovery or death.	Result of autopsy and microscopic examination.	Remarks.
46	May 15, 4 p. m.	Large albino rabbit, No. 11.	Injected three or four drops of aqua ammonia into the trachea from without, the trachea being laid bare and a small opening cut into it.	Died May 18, 1 p. m., in convulsions, 69 hours after inoculation. During sickness breathing of the animal was extremely affected, very forced, deep, the rabbit opening the mouth widely at each straining effort, and raising the head; did not take food except the last twelve hours before death, when he seemed to feel easier.	Wound in skin and muscles covering the trachea was suppurating; tracheal wound had healed. All organs strongly hyperæmic, and tubercular nodules recognizable by naked eye. On opening the larynx and trachea, a well-developed pseudo membrane of 1 to 3 mm. in thickness was seen, which reached below the bifurcation and into the smaller bronchia. It resembles fully in color, consistency, and easiness of detachment, the natural croupous membrane, and is perfectly identical with the latter upon microscopic examination. Micrococci are abundant, both in spheres and disseminated; none in internal organs except the lungs. Tubercles most prominent in the lungs, spleen, and lymphatic glands. Hemorrhagic infarction in lungs.	
47	May 15, 4 p. m.	Large albino rabbit, No. 12, about 4 years old.	Treated with ammonia similarly to the foregoing.	Died May 18, 4 p. m. 73 hours after inoculation. Animal seemed not to suffer and took food well; death in convulsions, which lasted about 3 hours.	External wound as well as that of the trachea had perfectly healed. Lesions perfectly similar to those of foregoing rabbit, only less intense in degree. Tubercles more scarce; lungs less hyperæmic and less infarcted. No micrococci in blood; pseudo-membrane fully developed and perfectly similar to foregoing. Bacteria and micrococci present in membrane and in lungs, but not in other organs.	
48	May 28, 12 o'ck.	Albino rabbit, No. 7.	Treated with ammonia like foregoing rabbits, experiments 46 and 47.	Died May 30, 11 a. m., 71 hours after operation.	Lesions fully identical with last rabbit, experiment 47.	
49	May 28, 12 o'ck.	Cat, No. 7	Same as last experiments, 46, 47, and 48.	Died May 30, 2 p. m., 50 hours after operation.	Lesions and well-developed false membrane similar to those in the last three rabbits, but here absence of tubercles. No micrococci in blood, and none in organs.	
50	May 28, 12 o'ck.	Dog, No. 3	Same as last	Great difficulty of breathing and inability to swallow followed the operation, but animal was artificially fed with milk, &c.; 12 days after the operation seemed to be recovering; killed June 9th.	Body much emaciated; skin wound healed, while tracheal wound was open yet; slight congestion of tissues around trachea. In many places on the mucous membrane of trachea traces of disappearing false membrane seen; whole trachea covered by thick tenacious mucus containing large quantity of leucocytes, some giant cells, and micrococci in moderate quantity. Spleen highly tubercular, tubercles in liver, lymphatic glands, and some in lungs. No bacteria in blood taken from jugular vein immediately after death.	

Fourth series of experiments.—Injection of ammonia into the trachea.—Continued.

Number of experiment.	Date.	Animal.	Inoculation.	Recovery or death.	Result of autopsy and microscopic examination.	Remarks.
51	June 8, 4.30 p.m.	Fresh rabbit, No. 25, about three months old.	Treated with ammonia similarly to foregoing five experiments, 46, 47, 48, 49, 50.	Died June 9, 4 p. m.; no convulsions.	Autopsy made immediately after death. Wound in skin healed; tracheal wound open; the tissues around latter strongly hyperæmic; trachea nearly filled by false membrane. A teased preparation of membrane taken five minutes after death showed the usual elements of a natural diphtheritic membrane with great abundance of micrococci; the blood did not contain micrococci. Lungs much congested; its vesicles largely filled with croupous exudation, blood corpuscles, and micrococci. All other organs normal and not containing bacteria.	
52	June 8, 4.30 p.m.	Rabbit, No. 26....	Same as last	Died immediately from operation, too much ammonia having been given.		

The experiments which are recorded in the last table show that ammonia is able to produce in the cat and dog as well as in the rabbit a pseudo-membranous trachitis. Professor Oertel states that the membrane produced by the cauterization of the trachea differs from diptheritic membrane in containing no bacteria. What has led him to such an assertion, we cannot comprehend. When the death occurred very quickly bacteria and micrococci may have been less abundant in the traumatic membrane than in that taken from the throat of patients, but when the animal survived some days and the bacteria had sufficient time to develop themselves—when, in other words, they were afforded as good opportunity of growth as in the natural disease—they were immensely abundant, in some cases seeming to make up a large part of the bulk of the membrane. *A priori* we would expect this result, since we have demonstrated that there is no physical difference to be found between the micrococcus of the mouth and the micrococcus of diphtheria. When then trachitis under the influence of the irritant is set up and exudation poured out, it seems a necessity that the micrococcus shall rapidly spread in the soil thus provided for it. To see whether organic irritants other than diphtheritic exudations will produce a pseudo-membranous trachitis, the following experiments were performed:

Fifth series of experiments.—Inoculation with foreign bodies, pus, &c., in the trachea.

Number of experiment.	Date.	Animal.	Inoculation.	Recovery or death.	Result of autopsy and microscopic examination.	Remarks.
53	May 19	Large rabbit, No. 14. See experiment 21.	Inoculated in the trachea with slough from a bed sore.	Wound healed rapidly, the animal recovering completely.		
54	June 3	Small rabbit, No. 28. Fresh rabbit.	Inoculated in the trachea and in the thigh muscles with exudation from throat of a scarlet fever patient.	Died June 12..................	Large cheesy lump on thigh. Some congestion and translucent mucus around tracheal wound which had not healed; no false membrane. No lesions in the organs; not examined for micrococci.	Case X.—From Dr. Fulton, the matter being product of ulceration of a scarletinal sore throat.
55	June 3	Small rabbit, No. 29.	Inoculated in the trachea only, with the same matter as last.	Died June 10..................	Skin wound healed; upon dissection a cheesy abscess found below subcutaneous tissue, pressing upon the trachea, and probably having been the cause of death. No other lesions perceptible. No micrococci in blood. None in organs.	
56	June 8	Small rabbit, No. 30.	Inoculated in trachea with the pseudo membrane produced by ammonia in rabbit No. 25, experiment 49.	Animal well June 18..........		
57	June 8	Small rabbit, No. 31.	Same as last................	Killed June 16................	No lesions except congestion of trachea and large cheesy lump between the trachea and skin.	
58	June 8	Small rabbit, No. 32.	Inoculated in trachea with purulent mucus taken from trachea of dog No. 3, experiment 48.	Died June 11..................	No lesions in any organ perceptible; tracheal wound not healed. No bacteria in blood.	
59	June 9	Large rabbit, No. No. 33.	Inoculated with ichorous pus in trachea.	Animal well.		
60	June 10	Small rabbit, No. 34.	Inoculated with pus in trachea,	Found dead June 11...........	No lesions except congestion of trachea.	
61	June 10	Small rabbit, No. 35.	Same as last.	Died June 18..................	Large cheesy lump between skin and trachea. Wound in trachea not healed: on opening the trachea a distinct pseudo-membrane of from 1 to 1½ millimeters in thickness was found, prominently seen only below the tracheal wound; *i. e.*, in the lower half of the trachea and the bifurcation. Microscopically, this membrane was identical with the natural diphtheritic membrane and with those produced by introduction of ammonia, and of diphtheritic matter in the trachea. Micrococci in large quantity all through it. Cheesy abscess was found in the left lung; many air vesicles of both lungs filled with a croupous exudation containing multitudes of bacteria; prominent miliary tubercle in all organs. No fungi in the kidneys; blood not examined.	

Fifth series of experiments.—Inoculation with foreign bodies, pus, &c., in the trachea—Continued.

Number of experiment.	Date.	Animal.	Inoculation.	Recovery or death.	Result of autopsy and microscopic examination.	Remarks.
62	June 10	Small rabbit, No. 36.	Inoculated with ichorous pus in trachea, and also deep in muscle.	Died June 17	Large cheesy lump upon trachea, the latter much congested. Within the trachea a very distinct pseudo-membrane was developed in the lower half of the same macroscopic and microscopic character, as that of last experiment. Croupous inflammation of lungs. Other organs normal.	

In looking over the last table, it will be seen that in two of the ten experiments pseudo-membranous' trachitis was caused by the introduction of organic matter into the trachea. In both of the cases in which false membrane was produced the injected material was pus; and it will be noticed that only four such experiments were made, so that the proportion of successful result is very large; larger, indeed, than with true diphtheritic exudation in our experiments.

Trendelenburg found that not only ammonia, but also various other chemical irritants are capable of causing the formation of false membrane in the trachea. Many years since it was proven that tincture of cantharides will do the same thing. It would seem, therefore, that in the trachea the formation of a pseudo-membrane is not the result of any peculiar or specific process, but simply of an intense inflammation which may be produced by any irritant of sufficient power. The experiments so far detailed seem to establish the following propositions:

First. *That it is difficult to produce in the rabbit a rapid septic disorder with the matter taken from ordinary cases of so-called diphtheria as we see them in Philadelphia.*

Second. *That tracheal inoculations with this matter will sometimes cause a pseudo-membranous trachitis.*

Third. *That both septic animal matter and non-organic irritants placed in the trachea cause pseudo-membranous trachitis which we have failed to distinguish from diphtheritic trachitis, the membrane in both cases containing micrococci.*

Fourth. *The occurrence of a false membrane in the trachea is the result not of the specific character but of the intensity of the inflammation.*

SECTION B.

EPIDEMIC DIPHTHERIA.

After studying the subject of endemic diphtheria, we next made trial of material from Ludington, and with very different results.

Sixth series of experiments.—Inoculation with epidemic diphtheritic matter from Ludington.

Number of experiment.	Date.	Animal.	Inoculation.	Result.	Autopsy and microscopic examination.
63	1881. June 23	Rabbit	In trachea with matter (from Roche case), material three days old.	Died June 26	Autopsy one hour after death. A huge diphtheritic ulceration occupying whole front of neck. Trachea full of exudation, which extends to the pharynx, tonsils, roof of mouth, and back of tongue; exudation not very tough, full of micrococci, bone marrow (examined fresh) filled with micrococci. Microscopic examination of organs showed—lung croupous pneumonia; liver and kidneys, cloudy swelling, with hemorrhagic infarctions, and only a few of the arterioles and capillaries blocked up with micrococci masses; spleen normal, and not containing micrococci.
64	June 23	Rabbit	Same as last	Died June 27	Two hours before death, blood taken in tubes from the jugular coagulated instantly, and contained an enormous amount of micrococci. Autopsy immediate; at place of wound around trachea, a large ulceration filled with exudation, which was composed of leucocytes fibrin and micrococci; mucous membrane of trachea inflamed; larynx filled with pseudo-membrane. The latter contained abundantly micrococci. Lungs, croupous pneumonia; rest of organs normal, and no micrococcus emboli after very careful examination.
65	June 23	Rabbit	Same as last	Died June 28	Blood examined after death full of micrococci; a large sloughing diphtheritic ulcer at seat of inoculation, with much exudation composed largely of micrococci, but containing numerous rod-bacteria also; trachea inflamed, containing very little exudation. Double croupous pneumonia; also empyæma. Rest of organs normal. No micrococci could be discovered in any of the organs except in the air-vesicles of lung.
66	June 23	Rabbit	In vagina, with diphtheritic matter.	Negative.	
67	June 23	Rabbit	Diphtheritic material put into mouth and throat without scarification.	Negative.	
68	June 23	Rabbit	Diphtheritic membrane from Smith's case, 5 days old, placed in pocket of muscle of thigh.	Died July 6	Autopsy immediately after death. Blood full of micrococci; a large ulcer with abundant diphtheritic exudation, composed chiefly of micrococci at seat of inoculation; liver full of small pyæmic abscesses (!). Marrow of bone full of micrococci. Kidney and liver contained some micrococcus emboli; rest of organs normal.
69	June 23	Rabbit	Diphtheritic membrane same as last.	Died June 26, 71 hours after inoculations.	Blood from ear examined four hours before death contained micrococci, not very abundantly. Autopsy a few minutes after death. Blood from jugular vein full of micrococci; at seat of inoculation an almost gangrenous diphtheritic ulcer, surrounded by widespread œdema of subcutaneous cellular tissue; few pyæmic abscesses in liver; lung croupous pneumonia and some purulent pleurisy. Rest of organs normal, and not containing micrococci.
70	June 23	Rabbit	Diphtheritic membrane 4 days old (from case of Nelson), placed under skin.	Was sick, with periods of getting better, until July 11, when it died.	Autopsy some hours after death. Blood contained no micrococci; did not coagulate rapidly; in no way perceptibly abnormal, its seat of inoculation a cheesy lump with micrococci. Liver with small pyæmic echinococci cysts filled with granular matter and pus; widespread tuberculosis of internal organs; no micrococci found in bone marrow and spleen (which were ined).
71	June 23	Rabbit	Same matter as last put in pharynx by scarification.	Negative.	
72	June 23	Rabbit	Same matter as last put in eye; conjunctiva scarified and eyelids sewed up tightly.	At first considerable local inflammation about eye, which soon subsided; animal seemingly recovered, but was found dead July 16.	Liver with pyæmic abscesses; other organs normal, and not containing micrococci.

Sixth series of experiments.—Inoculation with epidemic diphtheritic matter from Ludington—Continued.

Number of experiment.	Date.	Animal.	Inoculation.	Result.	Autopsy and microscopic examination.
	1881.				
73	June 23	Rabbit	A piece of diphtheritic kidney (from Roche case), 3 days old, inserted under skin.	June 30, rabbit very ill; died July 1.	Blood taken from jugular (June 30) by means of sealed tubes clotted at once, was full of micrococci. Autopsy some hours after death. Liver studded with pyæmic abscess; spleen swollen and dark; rest of organs normal, and in none of them could micrococci be discovered.
74	June 23	Rabbit	Same as last	Died July 6	Autopsy immediate. Blood full of micrococci; large diphtheritic ulcer at place of inoculation, with very profuse membranous exudation. Liver full of pyæmic abscesses. Organs not examined for micrococci.
75	June 24	Rabbit	Hypodermic injection of about 3 drops of blood taken four days before from a fatal case of diphtheria in Ludington.	Died July 3	No micrococci in blood. No lesions discovered elsewhere.
76	June 24	Rabbit	Same as last.................	Negative.	
77	June 24	Rabbit	Injected 4 minims of saliva 4 days old.	Died July 11	Autopsy. No micrococci in blood; no evidence of local lesion; internal organs slightly tubercular.

REMARKS.—The term pyæmic abscess, used on several occasions, is meant to express a small collection of pus or cheesy matter made up of débris, cells, and micrococci not included in a cyst, with or without evidences of echinococci in them.

An examination of the records just given shows that the Ludington diphtheritic matter acted as a very deadly poison upon the animals inoculated with it. In three rabbits, portions of the membrane were placed in the trachea with uniformly fatal results (Experiments 63, 64, 65). In three rabbits (Experiments 68, 69, 70), membrane placed under the skin or in the muscles acted as promptly as did that inserted in the trachea. The experiments in which the inoculation of membrane had no effect were those in which the poison was placed upon an open surface where it was liable to be washed off. Such were Experiments 66, 67, and 71, where the vagina and mouth were selected. In Experiment 72, the membrane was more or less imperfectly retained in position by sewing the eyelid over it, and the result was somewhat doubtful.

In two instances (Experiments 73, 74), instead of using membrane we employed minute pieces of kidney for inoculation, and with precisely the same effect, namely, rapid death, with characteristic lesions. Injections of minute quantities of blood and saliva into the veins (Experiments 75, 76, 77) gave, however, entirely negative results, with one very doubtful exception.*

It will be seen that the effects produced were entirely different from those which were obtained previously with Philadelphia matter. The results of the two series of experiments may be summed up in a few words, as in the following proposition: *Whilst inoculation of the rabbit with false membrane from endemic or ordinary Philadelphia diphtheria is rarely followed by rapid systemic infection, the placing of material from cases of malignant epidemic diphtheria in the trachea or under the skin is usually fatal; the characteristic post-mortem lesions consisting in the presence of micrococci in the blood, and sometimes also in the internal organs, along with severe inflammation at the point of injury, where there is produced an exudation resembling diphtheritic membrane, and crowded with micrococci.*

The question which naturally arises at the present juncture is: Is the affection produced in rabbits the same as diphtheria of man? Any one who has carefully studied the able, though not sufficiently known, pamphlet of Drs. Curtis and Satterthwaite will agree with us in believing that they obtained in some cases results similar to those which were yielded by the Ludington material, but in other instances effects like those produced with Philadelphia diphtheritic material. The portion of their text relating to this matter is so important that we quote it in full:

"In the above described disease we failed to see anything specifically resembling diphtheria as it occurs in the human subject. The whole story seemed to be one of local irritant poisoning, which always tended towards the production of an abscess at the site of inoculation, with greater or less concomitant hyperæmia, ecchymoses, and serous infiltration of neighboring tissues, according to the degree of virulence of the inoculated poison. According, also, to the severity of the primary lesions, the animals would die or survive the immediate effects; and according to the secondary history of the mass infiltrated with leucocytes—according, namely, as the mass was reabsorbed or softened and ulcerated—the animal survived unaffected, or slowly wasted away and died of exhaustion. But it might, not without reason, be argued that a rabbit is a widely different animal from a man, and that a disease induced by subcutaneous inoculation might naturally differ in its manifestations from the same occurring idiopathically; hence, that the described affection of rabbits might still be true diphtheria, although wanting in the specific characteristics of that disease as seen in the human subject. To determine this point we proceeded to try if effects similar to the foregoing would follow the inoculation of a material resembling diphtheritic membrane in its anatomical and chemical character, but yet not only not diphtheritic, but even incapable of producing any noxious effect under circumstances where diphtheritic membrane often proves highly infectious. Such a material presented itself in the scrapings from the upper surface of a somewhat 'furred' tongue from a healthy person. These scrapings, while obviously not infectious when brought in contact with the pharyngeal mucous membrane, yet contain anatomical elements of similar character, and in similar vital condition, to those of the diphtheritic membrane. They also swarm with countless bacteria.

"Such scrapings, inodorous when fresh, acquire a peculiarly offensive fœtid smell even within a few hours. Inoculations with this pulpy material were then made in the usual way, with the following results: Three animals were inoculated with the matter freshly removed. Of these, one died between the fourth and fifth day with a lump in each thigh, in all respects similar to that produced by the diphtheritic inoculation. One died on the fourteenth day, with similar lumps, which had softened and ulcerated; and the third on the twenty-fifth day, with widely extended burrowings of pus and secondary peritonitis. Four other rabbits were inoculated with tongue-scrapings, twenty-four hours old and fœtid. Of these, the first developed a large lump of the usual character in twenty-four hours. This was then removed entire for study, and the animal survived with no further lesion. The other three animals were let alone; all developed the usual lesions, and all died on respectively the fifth, nineteenth, and twenty-fifth days. A third series of two rabbits were inoculated with the mixed scrapings of five successive mornings, which were exceedingly offensive to the smell. One died on the sixth day with the usual lumps, but as this was a young animal from a litter some of which died without having been experimented on at all, it is an open question whether or not the death in this case was due to the inoculation. In the other rabbit lumps developed, which ulcerated and discharged foul matter. The animal suffered also in its general health, but ultimately recovered.

"These series of experiments thus developed the important fact that certain non-diphtheritic and non-infectious matters will, when inoculated upon the rabbit, produce a disease closely similar to, if not identical with, the disease caused by the inoculation of diphtheritic membrane, and one, also, equally fatal in its effects. But inasmuch as tongue-scrapings are open to the suspicion of containing some peculiar poison derived from the animal body, we determined to experiment with a substance which should be free from such objection, while still resembling diphtheritic membrane and tongue-scrapings in the matter of being putrescent and swarming with bacteria. We accordingly chose Cohn's fluid, which had passed into a state of decomposition. This fluid is simply a solution in distilled water of ammonium tartrate, potassium phosphate, and magnesium sulphate, to which also a little calcium phosphate is added. Upon exposure in a warm place, bacteria appear in this fluid in great numbers, and out of the salts present new compounds are formed of a strongly putrid smell. Inoculations were made with this putrescent material, as follows: Two animals were inoculated in the usual way with the pulpy sediment forming at the bottom of the bottle, and obtained by straining the fluid. Both developed the usual purulent lumps, but with little attendant irritation or constitutional disturbance. In both, the lumps gradually disappeared by absorption and atrophy, and the animals survived. Four rabbits were inoculated by hypodermic injection with the lower stratum of liquid in another sample of the decomposed fluid. Lumps, as usual, formed at the site of each injection; one animal died on the tenth day, the other three survived. Four rabbits were injected hypodermically with the upper stratum of liquid in still another sample. Lumps again appeared at each inoculated spot, but they were small, and all the animals survived. The same procedure in four other rabbits with a fourth sample of fluid produced like effects in three of the animals, but in the fourth no lumps discoverable by feeling the spot could be found. Fourteen animals in all were thus inoculated with the putrid Cohn's fluid. Thirteen of them developed lesions identical in appearance with the characteristic lesions from inoculations with diphtheritic membranes

* There is some reason for suspecting that a primary local disease is a necessity in the production of diphtheria, and that injections of diphtheritic matter into the blood will not cause the disease, unless by embolic arrest and formation of local depots of infection. Experiments upon this point are much needed, and we hope to make them at some future time.

and tongue-scrapings, but the collateral effects were not so severe, and only one animal died from the effects of the inoculation. In short, then, putrid Cohn's fluid, inoculated upon the rabbit, poisons after the same manner as diphtheritic membrane, though not to the same measure.

"It would seem, therefore, that the disease produced in the rabbit by inoculations of diphtheritic matter is not only not specifically diphtheritic in character, but not even peculiar to the diphtheritic infection; since a disease essentially similar, if it be not pathologically identical, is producible, though in variable intensity, by inoculations of material at once non-diphtheretic and non-infectious to human mucous membrane, and even, it may be, not of animal origin. This fact being apparently established, the important corollary follows, that pathological and pathogenetic conclusions drawn from the effects of diphtheritic inoculations of the rabbit do not, of necessity, apply to the disease, diphtheria, as it appears in the human subject. The many current hypotheses, in the premises, therefore, which rest upon such animal experimentation, are built upon a quicksand.

"This conclusion being accepted, it was plain that to attempt to elaborate the pathology of the diphtheritic process by study of the rabbit's inoculation disease would be a waste of time, and all thoughts of the same were accordingly abandoned. But though the inoculation disease is not necessarily nor even probably diphtheria, yet it is possible, and indeed probable, that the poisonous element in the diphtheritic membrane, which will produce diphtheritic infection in man, is the same kind of thing as that which produces the inoculation disease in the rabbit. Hence it seemed to us to be a useful research to try to discover the nature of the infecting principle, whether of diphtheritic membrane, tongue-scrapings, or Cohn's fluid, which produces the inoculation disease."

Notwithstanding the shrewd reasoning of the authority just quoted, the correctness of their conclusion does not seem to us established. The fact that something else besides diphtheritic membrane will produce in the rabbit symptoms similar to those caused by the membrane does not disprove that the disease developed by the diphtheritic inoculation in the rabbit is diphtheria; it may be that putrid tongue-scrapings are capable of acting as a diphtheritic infective matter. In a previous chapter we showed that the micrococci of such tongue-scrapings are not distinguishable from those of diphtheria. Moreover we have proven that almost any substance placed under the skin of the rabbit is capable of producing death, and that such death is preceded by the formation of cheesy lumps, the membrane of malignant diphtheria kills the rabbit rapidly without producing these lumps; evidently the tongue scrapings, &c., used by Curtis & Satterthwaite, acted like the membrane from our Philadelphia cases, and did not cause true systemic infection.

On the other hand, if we examine the general constitutional symptoms exhibited by the systematically infected rabbit we find they are a progressive failure of strength, with fever, such as are seen in the man suffering from diphtheria. If we examine the local symptoms the similarity is even more close, a membrane not to be distinguished by the microscope from that of diphtheria in the trachea, or if the inoculation has been made in the muscle a local exudation similar in all its elements to this membrane. Drs. Curtis and Satterthwaite seem to rely upon the fact that in inoculated animals membranes do not from, except at the point of inoculation. We do not think this cogent. The cases of diphtheria in which membranes form elsewhere than at the original point of disease are certainly in the minority in man: and according to the best modern pathologists it is probable that these secondary formations are the result of secondary local infections and are not the direct result of the constitutional disturbance. Would any one deny that a case of disease in a child was diphtheria because membrane did not form elsewhere than in the throat?

Finally the post-mortem lesions are not to be distinguished in the rabbit dead of an artificial diphtheritic trachitis and a child dead of malignant diphtheritic trachitis. As therefore the poison is the same in the rabbit and in the man, as the symptoms induced are very similar and the post-mortem results identical, we are forced to believe that the disease produced by the inoculation of the rabbit with malignant diphtheritic membrane is essentially diphtheria.

Before considering further the nature of the diphtheria poison we will report some experiments which we have made to determine whether it is possible to pass the disease from rabbit to rabbit.

Seventh series.—Inoculations with diphtheritic products from animal to animal.

Number of experiments.	Date.	Animal.	Inoculation.	Result.	Autopsy and microscopical examination.
78	June 26	Rabbit	Piece of heartclot from rabbit No. 7 put under skin.	Died July 4	Autopsy some hours after death external wound healed, with small cheesy lump; no micrococci in blood; organs all tubercular.
79	June 27	....do	Inoculated with false membrane from rabbit No. 2.	Died July 13	Autopsy, some hours after death. External wound healed, with a very small cheesy lump; organs tubercular; no micrococci in blood.
80	June 28	....do	Put piece of membrane in jugular from rabbit No. 3.	Negative.	
81	July 6	... do	False membrane from rabbit No. 1 put in trachea.	Died July 9	Autopsy, two hours after death. Blood full of micrococci, also bone marrow; trachea with a moderate amount of pseudo-membrane; lung croupous pneumonia and purulent empyæma; spleen small, atrophied; liver with pyæmic abscesses (?); rest of organs normal, and not containing micrococci.
82	July 6	....do	False membrane from rabbit No. 1 put in trachea.	Died July 14	Autopsy; large diphtheritic ulcer at point of inoculation, the slough containing all kinds of bacteria, but micrococci predominating; no micrococci in blood, spleen, or marrow of bone; no pyæmic abscesses in liver.

These experiments certainly show that the membrane obtained from inoculated rabbits is capable of causing death; but they also indicate that its toxic power is not as active as that of the original Ludington diphtheritic membrane, since omitting Experiment 79 as doubtful, in half the cases tuberculosis, and not acute systemic infection, was induced. It will be further seen that this result approaches somewhat that obtained with the diphtheritic membrane from Philadelphia, and that we must consider that the poison grows less active by transmission through the rabbit.

The question now presents itself squarely before us, what are the relations of the micrococci which exist in diphtheria to the disease? Are they the poison of the disease, or in other words are they capable of producing it? The absolute, final answer to this question can only be made by producing disease in the animal by micrococci isolated from the remainder of the diphtheritic poison. The difficulties to be overcome in such an attempt are very apparent. Three classes or lines of experiments at this juncture present themselves:

First. The study of the influence of filtration upon the poison as contained in the diphtheritic membrane.

Second. The study of the action of the isolated micrococci as they are to be obtained from urine.

Third. The study of the action of micrococci raised in culture chambers entirely away from the original poison.

In regard to the first of these methods, it is plain that the attempt must be to filter, as completely as possible, out all solid particles from membrane, rubbed up with water; and also that if it be found that the filtrate is innocuous and the matter remaining on the filter still poisonous, the logical deduction is simply that the poison is particulate and not soluble. It is impossible by this method alone to progress further and prove that the micrococci, and not the bits of fibrin, white blood cells, &c., are the materies morbi.

Under the present head we have no new facts to offer. We have lacked apparatus, time, &c., especially a sufficient supply of diphtheritic membrane to carry out the work. The deficiency is, however, of little importance, on account of the thorough, careful labors of Drs. Curtis and Satterthwaite, from whose pamphlets we quote *in extenso*.

"The next point to be determined was whether the poisonous principle is in solution in the fluid of the inoculating materials or whether it resides in the solid elements of the same. For this inquiry aqueous infusions of the infecting matters were filtered and comparisons made of the effects of inoculation of the filtered and unfiltered fluids. Filtrations were made through various thicknesses of ordinary filtering paper and also through porous clay. The experiments with paper-filtered fluids were as follows: An infusion of diphtheritic membrane was made and filtered through a double paper filter. The filtrate, which was clear and odorless, was injected hypodermically into three rabbits. All survived, two without even any local lesion, but the third with a large lump of the usual character, containing living bacteria, upon one side. None of the animals seemed to suffer in general health. At the same time the unfiltered infusion was injected into three other rabbits, and all of them died before the end of the third day with severe lesions."

"As may be at once seen, the general result of the above inoculations was that paper filtration tended to diminish the poisonous virulence of the infusions. But the experiments were not thorough, for the filtration was insufficient to entirely remove certain of the solid constituents (bacteria) from the infusions. The difficulty was that from the small quantities of diphtheritic membrane at our dis-

posal, we could never obtain a large enough bulk of strong infusion to permit of repeated paper filtration, such as alone would separate, with reasonable thoroughness, all the solid elements of the infusion. We were forced therefore to turn to other infectious infusions, where the requisite bulk of fluid could be had to test the matter thoroughly. We accordingly took Cohn's fluid and filtered it as follows, fresh filters being used at each successive filtration: Twice through single filters of ordinary gray filtering paper; twice through double filters of the same; once through a triple, and once through a quadruple filter; and, finally, thrice through quadruple filters of fine white filtering paper. The final filtrate, instead of the milky appearance of the original fluid, was but faintly opalescent, and, what was interesting and suggestive, had entirely lost the strong putrid smell of the non-filtered fluid. Under the microscope (one-tenth inch immersion objective of J. Beck), the fluid appeared perfectly clear, except that about half a dozen small bacteria were to be found in each microscopic field. This filtrate was then injected into four rabbits, four other rabbits at the same time receiving injections of the unfiltered fluid. The latter animals all developed the usual lumps at each site of injection, but all those injected with the filtrate remained absolutely unaffected. No lumps whatever could be felt upon the thighs at any period; and, to make sure, the skin over one thigh was snipped on the fourteenth day, and through the "window" thus made the whole subcutaneous territory was thoroughly inspected. Not the slightest lesion was to be found; it could not have been told that the region had been inoculated at all. Here, then, we seemed to have positive proof, so far as the experiments went, that thorough paper filtration would remove entirely the infectious element of the putrid Cohn fluid. But here the following possible source of error was acutely pointed out by a friend. During the very numerous filtrations above described, the fluid, falling slowly from the funnel drop by drop, had been submitted to a very thorough aeration as well as filtration; and, since it was conceivable that the infectious element might be a volatile chemical compound, it might be that in the experiment the inocuousness of the filtrate resulted from dissipation of a volatile principle by the aeration, instead of separation of a solid element by the filtration.

"To determine this point, a funnel was plugged with a rubber stopper pierced with a small hole, through which fluid could pass only slowly and drop by drop. Some putrid Cohn's fluid was then passed through this funnel as many times as the number of filtrations of the sample used in the last-described experiment. This aerated but unfiltered fluid was then injected into four rabbits, four other rabbits being at the same time injected with the original fluid fresh from the bottle. Lumps were produced at each site of injection in the rabbits treated with the aerated fluid, exactly as in those injected with the non-aerated. This test experiment thus removed the possible flaw in the evidence obtained by the filtration injections, and left no doubt that by the separation of solid elements of infectious infusions by thorough filtrations, the infectious principle tends to be removed.

"Further corroboration was afforded by experiments with a putrid infusion of calf's liver. Injections of the unfiltered infusion produced lumps as usual, but the fluid, when filtered, even through a single filter, failed to produce any effect.

"Simultaneously with the above-described experiments with paper filtrates, injections were practiced with some infusions filtered through porous clay. To obtain such filtrates, a porous clay battery cylinder was made use of. A piece of wide rubber tubing, connected with an exhausting syringe, was slipped over the closed end of the cylinder, and by exhausting the air in the tubing a little of any fluid in the clay cylinder would be drawn through the bottom of the same, of course suffering very perfect filtration in the passage. Infusions of three separate diphtheritic membranes, a sample of putrid Cohn fluid, and the infusion of calf's liver, already mentioned, were severally thus filtered. In all cases the filtrate was perfectly clean, entirely free from odor, and, examined microscopically with a $\frac{1}{10}$ inch lens, apparently totally devoid of all solid elements of any kind. The three filtered diphtheritic infusions were severally injected into three, two, and again two rabbits, the filtered Cohn's fluid and liver infusion each into a single rabbit. Not the slightest sign of a local lesion or of any constitutional disturbance followed any of these injections, while in all cases the unfiltered infusions were found upon injection to be more or less virulent.

"These various experiments thus seemed to demonstrate beyond reasonable doubt that the infectious element in diphtheritic membrane, putrid Cohn's fluid, and the like, is separable by filtration from an aqueous infusion. And when the filtration is thorough, as by means of a clay filter, the removal of all noxious principles from the infusion is apparently absolute. From this fact the inference may be fairly drawn that *the infectious principle or principles is resident in some solid element or elements of the gross material, and cannot be separated therefrom to any recognizable extent by the action of cold water.*"

It is hardly possible that any one can read this lengthy extract without being convinced of the correctness of the experiments made and conclusions drawn. Personal acquaintance with one of its authors makes us sure that the experiments were carefully performed and accurately reported. We considered it fairly established that the poison *of diphtheria is solid and particulate.*

As already stated in some detail in our bibliographical review, Dr. Letzerich has found that if the clear urine of a patient suffering from diphtheria be run through paper filters, and these filters afterward washed so as to remove all possible soluble contaminating matter and then dried, a paper is procured full of micrococci, but containing no other of the urinary elements except it be minute traces of epithelium, &c. This prepared paper Dr. Letzerich found to be as poisonous as is diphtheritic membrane.

In repeating these experiments of Dr. Letzerich we did not wash the filters before inoculation, so that our experiments may not seem to be as conclusive as they otherwise would be. When, however, it is remembered that the poison has been shown to be insoluble, solid, and particulate, it is plain that the failure to wash the filter loses its importance.

Eighth series.—With filter taken from urine.

Exp.	Time.	Animal.	Inoculation.	Result.	Autopsy and microscopical examinations.
83	June 23	Rabbit..	Vagina, without erosion.	Negative.	
84	June 23	...do.....	Filter paper in mouth scarified and tied up mouth.	Died June 25, about 36 hours after inoculation.	Autopsy some hours after death. Blood taken by tubes from the jugular vein full of micrococci in large numbers, both free and in zooglaea masses. No membrane in M. M. mouth, larynx or trachea. Lungs pale and collapsed. Liver full of small abscesses. Other organs normal. No micrococcus emboli found in organs.
85	June 22	...do.....	Filter paper as last.	Negative.	
86	June 23	...do.....	Filter put under skin of thigh.	Died during night of June 25.	Autopsy some hours after death. Blood full of micrococci; white blood corpuscles full of micrococci; numerous balls of them in blood and zooglaea masses also. At seat of inoculation a sloughing ulcer covered with diphtheritic exudation with much œdema around it. Liver with pyæmic abcesses. Other organs normal and not containing micrococcus emboli.

The experiments just reported show that the filter paper loaded with micrococci from the urine is even more poisonous than the membrane itself. It will be remembered that in no case did we succeed in inoculating with the membrane placed in the mouth of the rabbit; yet one out of two experiments with the filter paper was successful. No vaginal inoculation with any kind of diphtheritic matter has in our hands succeeded, so that the failure of Experiment 83 goes for nothing. In the only remaining trial the paper with the micrococci was placed under the thigh and death occurred in less than three days, the blood being crowded with micrococci and the internal organs markedly affected.

In order to determine whether ordinary urine contains any solid material poisonous to rabbits, we inoculated four of these animals with filter-paper, through which had been passed large quantities of normal urine. In one instance the paper was placed in the trachea, through an artificial opening; in the other rabbits the pellets were put in the muscles. None of the rabbits were sickened. The tracheal wound healed rapidly.

The force of the urine filter experiments seems to us very great. The amount of other solid particles in the urine was so small that it is very improbable that the solid particulate poison which caused the septicæmia was other than the micrococci. As the experiments have been performed by three observers (Letzerich and ourselves) their correctness can scarcely be challenged. They seem to us to prove that the micrococci are either the poison, and by their growth enter the tissues and destroy the blood corpuscles, or else that they by the processes of growth in the body produce a poison which is the true materies morbi, or else that they are saturated with the poison and act as carriers of it.

Our next series of experiments were made to determine whether it is or is not possible to produce diphtheria with the artificially cultured micrococci. In them a piece of blotting-paper, which had been moistened with the culture fluid containing growing micrococci, was

placed in the tissues or trachea of the rabbit. The experiments are as follows:

Ninth series.—Culture inoculations.

Exp.	Time.	Animal.	Inoculation.	Result.	Autopsy and microscopical examinations.
87	Aug. 8	Rabbit..	Fifth generation of Ludington matter in trachea.	Died Aug. 9	Autopsy some hours after death. No micrococci in blood; no local or other lesions.
88	Aug. 8	... do	As last	Died Aug. 23	Autopsy. Trachea healed. No micrococci in blood.
89	Aug. 8	... do	....do	Died Aug. 26.	Blood examined just before death; no micrococci in it. Autopsy, pneumonia.
90	Aug. 9	... do	Fifth generation from Ludington matter in thigh.	Died Aug. 24.	Autopsy some hours after death. No lesion in solid tissues; no micrococci in blood.
91	Aug. 9	... do	As last.......	Negative.	
92	Aug. 9	.. do	....do	Died Aug. 27.	Autopsy. General tuberculosis.
93	Aug. 9	...do	....do	Negative.	
94	Aug. 9	.. do	....do	do	
95	Aug. 9	...do	.... do	.. do	
96	Aug. 15	...do	Inoculated in the muscle of the thigh with third generation, Ludington matter.	....do	
97	Aug 15	...do	.....do	....do	
98	Aug. 15	...do	.....do	Died Aug. 23.	Autopsy some hours after death. No micrococci in blood.
99	Aug. 15	...do	....do	Negative.	
100	Aug. 15	...do	.. do	Died Aug. 29.	Autopsy some hours after death. General tuberculosis.
101	Aug. 15	...do	....do	Negative.	
102	Aug. 15	.. do	Inoculated in trachea with third generation of Ludington matter.	....do	
103	Aug. 15	...do	....do	...do .... do.	
104	Aug. 15	...do	....	Died Aug. 17.	Autopsy some hours after death. No micrococci in blood. Croupous pneumonia. No pseudo-membrane in trachea, but a simple catarrhal trachitis.
106	Aug. 15	...do	....do.......	Died Aug. 28.	Autopsy. No micrococci in blood; croupous pneumonia; other organs normal.
107	Aug. 15	...do	....	Died Aug. 28.	Autopsy. No micrococci in blood; general tuberculosis.
108	July 13	...do	Inoculated with the second generation of the diphtheritic matter in the thigh.	Died July 21.	Blood examined just before death; contained micrococci in considerable quantity, infesting white blood corpuscles and also some free. Autopsy immediately. Filter paper still in position surrounded by an inflamed area, but no pseudo-membrane. Liver does not contain abscesses; marrow of bone containing micrococci both in the cells and free; other organs congested, but no micrococcus emboli.

An examination of the records of these experiments shows that there is only one in which it can be positively affirmed that diphtheria was produced by the inoculation with *cultured* micrococci. This was the experiment 108, made with the second generation. All the experiments made with the third and fourth generations failed, or at best yielded doubtful results in that after death no distinctive evidence could be found of the existence of false menbrane at the place of inoculation or of micrococci in the blood. Fortunately, in Experiment 108, the result was decisive; and in a case like the present one positive experiment is not to be overcome by many negative trials. There is, however, a special reason why all the experiments, save the 108th, should have proved unsuccessful. The diphtheritic matter was two and more weeks old at the time of inoculation, as our first studies were naturally directed to the morphology of the micrococci under culture. It will be shown later on in our memoir that the fungus must have lost some of its vitality. Moreover, we allowed the cultures to grow longer than we should have done. Cultures rapidly made with fresh material would probably be effective beyond the third generation.

It has been established by the labors of Pasteur (address before the International Medical Congress, 1881) and others that fungal organisms are capable of losing their noxious powers under altered conditions of cultivation. For reasons, which shall be detailed hereafter, we believe that this is eminently true of the micrococcus now under consideration. Failure, therefore, to produce diphtheria with the third generation of cultivated micrococci from old stock is no evidence that the micrococci is not the materies morbi of diphtheria. The explanation of such failure is probably to be found in the tendency of the micrococci to relapse into its next stage or state under the more or less defective conditions of artificial cultivation. Then, again, we are convinced that quantity is a very important factor in the action of the diphtheritic micrococcus; that not only must the plant be in an active stage, but that also it must be in sufficient amount at the place of inoculation. The cultivated plant exists in very minute amount as compared with the natural plant, and in our culture inoculations the amount of the plant inserted into the animal was very small as compared with the mass inserted where membrane or kidney was employed. Whatever may be the explanation of the negative results with the third generations, it is certain that we have produced diphtheritic septicæmia with second generation's culture, and we believe that future research will confirm this, and show that *micrococci cause diphtheria by their power of forcing their way into the tissues and by their own excessive vitality overcoming the vitality of those tissues, changing their nutritive processes, destroying them, and finally getting into the blood itself, destroying its white corpuscles, and obstructing the circulation.*

Whilst this is our opinion, we do not think that at present it can be consider d positively proven that the micrococci themselves are the essential poison, and not simply the carriers of the poison.

A very important practical point to which we have paid some attention is as to whether diphtheritic matter loses its infective power. Curtis and Satterthwaite affirm that their researches show "that there is no relation between inoculable virulence of a membrane and the time after detachment that has elapsed before the material is used for inoculation." The only proof that they offer for this proposition is, however, the fact that membrane three days after removal was found by them as active as that just taken off. Surely this is a very slender foundation for so large a generalization. Our time was for some months so closely occupied with the more immediate necessities of our work that we were not able to make any experiments as to when the membrane begins to lose its activity, but the following experiments show that after a time the membrane even if kept perfectly dry does lose its contagious powers:

Tenth series.—Inoculation with two month old, dried Ludington diphtheritic material.

Exp.	Time.	Animal.	Inoculation.	Result.	Remarks.
109	Aug. 29	Rabbit..	Dried diphtheritic membrane in muscles.	Negative..	
110	Aug. 92	....do ...	...do	....do	
111	Aug. 29	... do ...	....do	....do	
112	Aug. 29	....do ...	...do	....do	
113	Aug. 29	....do ...	....do	....do	All these rabbits had been previously inoculated with culture plants.
114	Aug. 29	....do ...	.. do	....do	
115	Aug. 29	....do ...	.. do	....do	
116	Aug. 29	....do ...	....do	....do	
117	Aug. 29	....do ...	...do	....do	
118	Aug. 29	....do ...	....do		
119	Sept. 11	....do ...	Dried membrane in muscles.	....do	
120	Sept. 11	....do ...	Dried kidney in muscles.	....do	
121	Sept. 13	....do ...	Dried membrane in trachea ...	... do	
122	Sept. 13	....do ...	....do	Died Oct 1..	Autopsy some hours after death. No micrococci in blood; no severe trachitis or any signs of pseudo-membrane; severe double pneumonia. Rest of organs normal and no micrococci found.
123	Sept. 13	... do ...	....do	Negative....	The last four experiments were primary inoculations; *i. e.*, rabbits had not been previously used.
124	Sept. 13	....do ...	....do	....do	

These experiments do not seem to need comment. The diphtheritic matter employed had originally possessed the most virulent proper.

ties. But in sixteen inoculations, four of them into the trachea, not once did it produce any signs of disease. On placing the micrococci in the culture chambers the reason of this was obvious; they had lost their power of rapid growth and were as sluggish as plants taken from a furred tongue—a further evidence of the close connection between the power of growth of the micrococci and the infectious properties of the membrane containing them.

In finally considering the nature of diphtheria the facts which have been established should be carefully thought over. They may may be stated as follows:

The micrococci of diphtheria do not differ, so far as observed, from the micrococci of furred tongue, &c., except in their tendency to grow in culture fluids.

The micrococci of furred tongue or ordinary sore throat have a less tendency to grow under culture than have the micrococci of endemic non-malignant diphtheria.

The micrococci of endemic or non-malignant diphtheria have a much less tendency to grow under culture than have the micrococci of malignant diphtheria.

The rapidity of growth of the micrococci is in direct proportion to the malignancy of the case yielding them, and its contagiousness.

On exposure to the air diphtheritic membrane of the most virulent type loses its contagious power, and the micrococci *pari passu* lose their power of growing in culture fluids.

Under successive generations of artificial culture the diphtheritic micrococci lose their growth, activity, and also their power of infecting the rabbit.

It has not been experimentally directly proven, but it is a necessary inference from the two facts just stated, that under certain favoring circumstances the sluggish micrococcus puts on growth—activity, and, in all probability, *poisonous properties*.

Every grade of case can be found in man from an ordinary sore throat, through simple pseudo-membranous angina and trachitis, up to malignant diphtheria.

Any inflammation of the trachea of sufficient intensity may cause the formation of a pseudo-membrane.

A case may begin as one of sthenic "pseudo-membranous croup" and end as one of adynamic "diphtheria" with blood poisoning; and in cases of this character not infrequently no exposure to contagion is discoverable, and there is clinically every reason to believe that the blood poison has been developed within the body of the patient. The theory of the disease which we would deduce from these facts is that the micrococcus, which directly or indirectly causes the diphtheria, is not a specific organism different from that common to healthy and inflamed throats, but is an active state of that organism; that certain circumstances outside of the human body are capable of throwing this common micrococcus into this condition of active growth and engendering an epidemic of diphtheria. When diphtheria is thus epidemic the micrococci light upon a throat, and if the throat have little resisting power, as in the child, inflame it or increase a catarrh already existing into a violent inflammation, and also rapidly enter the blood and cause systemic poisoning.

On the other hand, a catarrh in a weakly subject may, in the beginning, be simply an inflammation from cold, but the ordinary micrococci in the throat or mouth, favored by the special conditions, &c., may gradually change from the dormant to the active state, and by and by act upon the throat, and at last force their way into the system, and a self-generated diphtheria be formed out of a "cold."

It has already been abundantly proven that there is no specific character detectable in the micrococci of diphtheria. The history of wounds infected with diphtheritic poison and of those infected with hospital gangrene lends further countenance to the idea that diphtheria and certain other septic diseases are really different manifestations of the one affection, the difference in symptoms depending rather upon the difference in the location than in a difference of the nature of the septic process. In order to test this, we have made a few experiments. The coming on of our winter work has, however, prevented our investigating the matter further as we otherwise should have done. The experiments performed are as follows:

Eleventh series.—Inoculation with gangrenous matter.

Exp.	Date.	Animal.	Inoculation.	Result.	Remarks.
125	Aug. 28.	Rabbit.	Inoculated in trachea with matter taken from a case of spreading gangrene, which destroyed the foot of a man in the Philadelphia hospital; it was full of micrococci.	Died Sept. 2, after suffering 2 days with severe trachitis.	Blood full of micrococci indistinguishable from those of diphtheria; trachea; inflammation with false membrane; liver full of collections of micrococci; other organs not examined microscopically.
126	Aug. 28.	....do. ..	As the last........	Rabbit was ill, but recovered.	

We do not claim that these experiments are sufficient to establish the identity of diphtheria and other forms of local gangrene, but they certainly favor such a belief. And we would respectfully suggest to the National Board of Health the great necessity of further research, especially upon the relations to diphtheria of scarlet fever, pyæmia, erysipelas, and various septic diseases in which micrococci that seem to be similar to those of diphtheria occur.

UNIVERSITY OF PENNSYLVANIA, *October* 1, 1881.

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SEWERAGE AND HOUSE DRAINAGE IN PHILADELPHIA.

SIR: The following compendium of a report made to me as expert and special agent of the Census Office concerning the sewerage and house drainage of Philadelphia is of general interest, and, with the consent of the Superintendent of the Census, I submit the same to you for publication.

The examination of Philadelphia's sewerage and house drainage system was made during the summer of 1881 by my engineering assistant, William Henry Baldwin, esq., civil engineer. The orders under which he acted required him, without reference to prejudices or preconceptions, to investigate the actual condition of the system and report upon it in detail. This report will be published by the Census Office in full, with diagrams, in connection with the social statistics of Philadelphia. In view of the present interest of the subject, the publication in the Bulletin of some of its more essential points have been thought advisable.

Philadelphia is sewered on what is known as the "combined" system, the same sewers serving for the removal of sewage and of storm water. Records of the rainfall of Philadelphia, from 1816 to 1879, taken at the Pennsylvania Hospital, show the precipitation to have varied from 23.35 inches, in 1819, to 61.187 in 1867. The next greatest rainfall (1873) was 58.286. In August, 1867, there fell 15.816 inches; and in August, 1873, 12.280 inches. Records of the water department of Philadelphia, published in the annual report of that department for 1876, show that the yearly rainfall, from 1810 to 1877, has increased at an average annual rate of about 0.3 of one inch, with no apparent increase of the summer rainfall.

The underlying rock of the city is gneiss and imperfect granite. Overlying the rock is a coarse stratum of gravel and sand of uneven thickness. The surface soil is usually clay. In the more elevated portions of the city the rock crops out at the surface.

The rise and fall of the tide of the Delaware River is over 6 feet.

Nearly the whole of the old city of Philadelphia, and a large portion of the present business quarter, lies from 20 to 40 feet above tide-water, giving ample natural drainage facilities. The original surface drainage was by means of numerous small streams having their origin within the city limits. The drainage of the country north of the city being intercepted by natural water courses, there were no considerable streams traversing the present densely settled districts. The smaller water courses, which formerly served for the surface drainage of the site of the old city and of its immediate vicinity, have been converted into brick sewers. There are in the suburbs or in parts now being built up several streams of considerable importance, and their treatment constitutes the most important problem of the sewerage engineering of Philadelphia, as thus far developed. Some of these larger works call for reference here; they will all be more fully described in the Census publication.

That known as the Hart Creek sewer, at a point 3½ miles from the Delaware River, along its probable course when straightened, has an elevation of 53.7 feet above the city datum (8.732) feet above the sea. This sewer is for a part of its course an open channel; between Seventh and Fifth streets it is constructed as a circular sewer 10 feet in diameter; and at Somerset avenue and Kensington avenue it is increased to a diameter of 16.5. In Somerset street east of Trenton avenue its flow is divided and it thus continues to the Aramingo canal, each of the twin sewers being 13 feet in diameter. The discharging capacity of the 16.5-foot sewer is 103,000,000 gallons per hour. The area of the drainage for which it provides is about 2,000 acres. The cost of the Hart Creek main, below Indiana avenue, 5,140 feet, had been to 1876, $322,137.81, being at the rate of $62.67 per foot. This does not include some expenses of litigation, land damages, interest, &c.; these added would carry the cost to about $420,000.

An area of about 700 acres is drained to the Aramingo Canal by a trunk-sewer in Huntingdon street. It occupies mainly the bed of an old creek, and the main line was built by the corporations of Kensington and Richmond before their consolidation with the city. At its outlet is a circular sewer 10 feet in diameter. It discharges 9.3 feet below city datum, or about at the level of mean low-tide, so that the flow is obstructed by tide-water during the greater part of the time. Although this sewer is built to provide for about 1 square mile, much of the district is still in a state of nature, and many of the streets now graded and built up are not sewered. The total length of the main sewer and its branches is but little more than 6 miles. Below Huntingdon street there are a number of small sewers, aggregating about 1¾ miles, which also discharge into the Aramingo Canal.

What is known as the Cohocksink is the most extensive system in Philadelphia leading to a single point of discharge. It reaches an area of about 2,800 acres, with a population of about 135,000. Until 1855 its main outlet remained an open water-way as far as the bridge at Thompson and Fifth streets. There were four principal systems draining into this water-way (the Cohocksink Creek); these still remain as built in early times, delivering the storm-water of their districts almost at the city datum-line, nearly a mile away from the outlet of the creek. This last mile is now occupied by sewers of great size and moderate fall, finally discharging at a depth of 11.16 feet below the city datum, or about 2 feet below low-tide.

Before 1855, when the outlying districts were independent corporations, their sewerage works were carried out independently, and a lack of uniformity is therefore obvious in different parts of systems which are now combined as in the present instance. One of the branch sewers of this system takes in a water-course originally a branch of the Cohocksink, one of whose ramifications has become a sewer in Susquehanna avenue, near Twenty-seventh street. This sewer and its branches, amounting in all to a length of 1 mile, carry the a drainage of a considerable cluster of houses on the high ground near Ridge avenue. The main sewer terminates in a wooden box, once covered with earth. This wood work has now fallen in pieces, and at points the earth has caved in. The *debris* thus falling into the sewer are covered with remnants of the offal of slaughtered animals in various stages of decay. The stream, after leaving the ruins of this temporary sewer, flows in an open water-way, takes in several smaller branches from other sources, and after a devious course through open field is taken into a sewer connecting it with the Cohocksink main. Other branches penetrate districts which are now completely covered. The outlet of the drainage of the Cohocksink area is into a slip surrounded by wharves, now used for the landing of lumber and building material. The discharge is usually below tide-level, and is sluggish. The flow of the tide in the slip is obstrubted by the piers on each side, and has usually but little current, hence the lighter matter, from the sewer float to the surface, while the heavier matters are deposited, gradually filling the slip with organic and other sediment. The 39 miles of sewers of this system not only drain an equal length of paved streets, but receive also the gutter flow of lateral streets for a considerable additional length. Although there are in this district but comparatively few water-closets or other house connections, the discharge of household liquid wastes and much garbage is by gutters leading to the sewers, so that a very large proportion of the filth of this population of 135,000 finds its way to the outlet. This outlet is only about 4,000 feet from the intake of the Kensington water-works, and the current flows back and forth at every change of the tide.

The Cohocksink sewer, between Front street and the Delaware River, has a sectional area of 188 square feet, with a total fall of 3 feet in 1,500. Its interior dimensions are, breadth 18.5 feet; height 12.66.

A more recent work is the Mill Creek system of West Philadelphia. This being of modern construction is of very much better character than the average Philadelphia sewerage. The total length of the sewer and its branch is about 12.5 miles, the main sewer being a tunnel with a width and height of 20 feet. It has a capacity of 302,000 cubic feet per minute, and drains an area of 4,600 acres. Two thousand six hundred and fifty-one feet of its length cost $278,360.44, being a cost per foot of about $105.

A considerable drainage still flows into the Schuykill River above the dam into the main water-supply of the city. In a communication from the park commissioners, June 16, 1877, to the chief engineer of the water department, enumerating the sources of pollution from the east and west park, it is stated that "a very offensive sewer empties into the river just south of Girard avenue bridge, passing underneath the same." This stream contains drainage from breweries, slaughter houses, water-closets, &c. The delivery of sewage into the Schuykill River below the dam, and into the Delaware River within tidal reach of these works, must in time become, if it has not already become, a serious sanitary evil.

In his "general notes" on the sewerage of Philadelphia, Mr. Baldwin cites as the most noticeable feature of the work, the great extent of territory in some instances carried to single outlets with a great size of main sewer. Notwithstanding this, at many points short

sewers deliver directly to the rivers, so that the number of outlets is almost as great as the number of slips or docks. Attention is also called to a remarkable uniformity of design. With the exception of the very large mains occupying the courses of ancient streams, most of the other sewers of Philadelphia are built now precisely as they were forty years ago. The cross-section is almost universally circular for mains and branches, the branches constituting of course by far the largest proportion of the whole. They are almost universally 3 feet in diameter, occasionally 2.5 feet. They are built with a single 4-inch ring, the lower half being lain usually without mortar directly upon the excavation which is formed to receive it. The upper half is laid in mortar and is built over centers. House connections are introduced at will, usually in the upper portion of the sewer, to avoid depth of cutting. The connection pipes are of various sizes, according to the caprice of the owner, and the connection is made in the manner best suiting the convenience of the plumber or his laborers, all without control on the part of the city officials. "The customary manner of making connection with a sewer is to knock a hole in it with a bar or hammer, and, after placing the connecting pipe, to place a few loose bricks above the broken place and fill up with earth. These loose bricks are soon displaced by rats, the earth caves, and the sewer itself sometimes falls in."

The method of laying the inverts of branch sewers without cement is defended on the theory that they thus act as subsoil drains and benefit adjacent land.

"The practice of making all branch sewers 3 feet in diameter, or occasionally 2 feet 6 inches, is still adhered to without exception. Water is carried in street-gutters until its accumulation is thought to be sufficient to maintain the water seal of the inlet basins, when it is taken underground and received into a branch sewer 2.5 feet or perhaps 3 feet diameter. A sewer of this size is so much too large for any demands that come upon it that deposits may accumulate to an almost unlimited extent before they form sufficient obstruction to the flow of water to cause an inconvenience, and in the mean time the organic or other perishable or decomposable matters slowly decay nad pass off in the form of vapors or gases through the inlet basin or the house connections into the atmosphere. Branches, then, instead of conveying away the sewage serve as rendering establishments or gas-works for converting household wastes and street dirt into atmosphere."

The inlet basins furnished at the corners of the streets are of small capacity, having a water seal of only 3 inches depth, and are connected with the sewers by large brick culverts. They require frequent cleansing. "This is done by removing the cast-iron covers and shoveling up the deposit into the street, where it is left to drain until it is carried away by the street-cleaning contractor or scattered by the wheels of passing carriages." It is a common practice in Philadelphia to turn out kitchen and laundry slops on the ground "to make its way by natural processes." This water runs through shallow ditches and across the paved sidewalks to the street gutter and thence to the most convenient inlet basin. So common is this practice that few street gutters in the city are free from kitchen and laundry slops, and almost every inlet basin is thus converted into a cesspool holding at all times more or less filthy water, grease, and nameless impurities. It is not an uncommon practice in the vicinity of markets or fruit-stands to throw refuse fruits and other decaying matter in the gutters and streets, and sometimes into the basins, and it is quite common in the spring season to see fish-stands along the curbstone, the waste and cleanings from which are thrown in the gutters, and are sometimes swept or washed into the basins and thence eventually into the sewers.

"NOTE.—Market street, corner of Twelfth, for several weeks in April and May, '81, and other places on Market, Chestnut, &c., were exact locations noted in regard to this matter."

"The manholes of the sewers usually consist of a 4-inch ring of brick work surmounted by a cast-iron frame and grating and closed by a wrought-iron hinged cover. These covers are seldom if ever raised, and are usually found to be so jammed and clogged with street dirt and so warped and bent out of shape by the passing traffic as to be opened only by the aid of an iron bar. When finally loosened, they open like the lid of a tea-pot. The cover sticks up in the way of passing vehicles, and must be closed again as soon as the inspection is over. (It is often a much greater task to close one of these covers than to force it open.) The sewers are therefore practically without any ventilation, and on raising one of these covers the rush of vapor, gas, and sometimes of steam is so great that some time must pass before one can look down into the sewer and see anything. Within the past few years some grated covers have been used for new sewers, but no attempt has been made to substitute them in the old ones; in fact, most of the old sewers are so offensive that it is doubtful if perforated covers could be used without creating a nuisance for some time.

"The accumulation of gas in the branch sewers of Philadelphia is rendered unavoidable by their shape and size, and by the lack of ventilation. A sewer, circular in section, with a diameter of 3 feet, cannot be kept clean until the flow of water becomes several inches deep. So much kitchen and laundry water is turned out on the surface of the ground and exposed to the air in the street gutters and basins that the supply for washing out the sewers is greatly reduced by evaporation, while the deposit gradually accumulating in the branch sewers retards the flow of water, and, by its decay, is constantly contributing to the supply of sewer gas."

ADMINISTRATION.

There are thirteen survey districts in Philadelphia, each of which is represented by a surveyor and regulator elected by the people. These officials constitute the board of surveys, of which the chief engineer of the city is the presiding officer. It decides the regulation of streets and public places, and all matters of drainage and sewerage. It being decided that a sewer is needed, the district surveyor makes a survey and profile, and the size of the sewer is fixed by an arbitrary rule referring to the number of acres to be drained and the rate of fall that can be secured, the limit of capacity being the discharge of one cubic foot per second for every acre to be drained, no public sewer being less than two feet six inches in diameter. The plan and the specification being approved, they are placed in the hands of the chief commissioner of highways, who receives proposals and enters into contract for their construction. All main sewers are built according to one form of specification, and all branch sewers according to another. All work is to be maintained and repaired by the contractor for a period of three years after construction. The construction of main sewers is under the control of the chief engineer of the city, and branch sewers under that of the chief commissioner of highways. The contractor is required to employ the surveyor and regulator of the district to give him the lines and grades for the construction of the work and to make out the assessment bills against abutting owners. He has to make also the returns and certificates. For all of this service *he is paid by the contractor*. The surveyors are engaged in private practice, and it would seem that the security of the city for the execution of good work is limited to the responsibility of the contractor to keep his structure in order for three years' time.

"The manner of connecting a new sewer with an old one has been observed in some branch sewers now in process of construction, and also by examinations made in the interior of some of the main sewers where branches have been connected in former years. The counter or lower half is first built and finished against the outside of the old sewer, when a hole is knocked through its side somewhat smaller than the new sewer, and the upper half or arch is then turned and finished against the outside of the old sewer, as before; hence the water, in passing from the new sewer to the old one, has to pass through the ragged, irregular-shaped opening made for the purpose.

"It is necessary to finish the bottom half of the new sewer before knocking a hole in the old one, because frequently the old sewer is found to contain so much rubbish that the water will run out and flow into the trench made for the new sewer. It is prevented from flowing back far by a temporary dam of clay and mud, and the new sewer is built in sections until the bottom rises above the level of the back water. Instances of this kind are not uncommon. A single case will serve as an example, where a branch sewer 3 feet diameter in Elizabeth street was connected in this way with an older sewer 2.5 feet diameter in Emerald street, found on knocking a hole in it to be nearly or quite half full of rubbish, brickbats, mud, and water. The fact that a sewer 3 feet in diameter is brought into one 2.5 feet is not important, as neither one of them will ever have water enough flowing through to fill it half full, unless it becomes obstructed."

Main sewers are constructed under the direction of the department of surveys, the chief engineer and his assistants. The specifications call for bids for constructing at a certain price per linear foot, including masonry, rock work, the necessary foundations and all other contingencies. The argument in favor of this system is that the city thus knows in advance how much the work is to cost and can make appropriations accordingly, and that the amount of work to be paid for is determined by measuring the number of feet completed. The contractor takes all the risk, and "if he meets an unexpected expense in one item must cover it by a corresponding saving in some other unless outwitted by the vigilance and integrity of the inspector In some of the more important work, an inspector is appointed to give his entire attention to the work and insure good workmanship and material, but in most instances this has not been done for want of an appropriation of funds to meet the expenses." There has recently been an improvement in the manner of construction of the larger sewers, the need for which is apparent, not only from "the present condition of some of the old sewers, as in Randolph street, from Thompson street to Montgomery street, built about 1870, and now settled out of shape in several places. The crown is cracked and in some places bricks have fallen out. Others have fallen in in some places, as in the old Huntingdon sewer, and in Fairmount avenue, below Front, in Moore street near Third street, and in other places."

MAINTENANCE AND REPAIRS.

Sewers, when completed, are transferred for future cleansing and repair to the department of highways, which is also charged with the maintenance of public roads, streets, and bridges. The cleansing of the streets, however, as well as the removal of ashes, garbage, and swill, is controlled by the board of health. Owing to this divided responsibility, it sometimes happens that "the health officer

complains that he cannot keep the streets clean because the pavements are out of repair, while on the other hand the officers of the highway department declare that they cannot repair the pavements because they are not kept clean." The cleaning of streets and the emptying of catch-basins are included in one contract, so that the more street dirt the contractor is able to have washed through the basins into the sewers, with which he has no concern, the greater his advantage.

The maintenance, repairing and cleansing of sewers is done under a separate contract. The specification is very simple but comprehensive, and requires the contractor to estimate in advance how many sewers are going to fall in during the coming year, and how much it will cost to repair them, and to fix a lump sum for which he will take all the chances. The contracts for the year 1881, all held by one contractor, amount to $15,000.

"Having assumed this responsibility, whenever complaint is made, or an inspector finds out from any source that a sewer has caved in, the contractor is notified to repair the break. This is done by digging out a place for the workman to stand, provided the hole in the street is not already large enough for that purpose, removing from the sewer what bricks are worth saving, and perhaps digging out some of the mud if much is found within reach. An arch is then turned over the broken place and the street restored. If there is considerable water flowing through the sewer the rubbish, mud, and débris are said to be carried away, but if a break occurs near a summit where but little water comes in, most of the rubbish is gradually spread along, and the water flows over its surface. Branch sewers being never less than 2.5 feet in diameter, an obstruction of considerable depth still leaves plenty of room for water to make its way off, and the presence of the obstruction is probably never found out unless the sewer gets entirely closed, or becomes so foul as to become a nuisance and cause of complaint."

Mr. Baldwin reports that he saw workmen standing in water at least 12 to 15 inches deep to repair a break within 500 feet from the summit. Such an accumulation of water of course indicates an obstruction, but the work was completed and covered in without its being removed (Twelfth street, opposite Wager, between Race and Vine). A record is kept of the notices for repair sent to the contractor, and he is obliged to return this notice, signed by the assistant commissioner in charge of the district, who acts as inspector, his signature vouching for the execution of the repair. "The opportunity offered for a personal inspection on the part of the assistant commissioners may be estimated when it is considered that there are six assistants for the entire city, who have to inspect the work done in the repairs of all kinds, not only of sewers, but of pavements, highways, roads, and bridges." "Breaks in sewers usually occur in the spring and fall, and are said to be caused principally by the action of frost upon exposed parts, but they occur also after heavy rains, and in such cases are doubtless due not only to the action of running water, but also to the increased weight and instability of soil saturated with water. Inlet necks, connecting basins with the sewers, often cave in as the frost leaves the ground; sometimes a sewer fails from the natural wear of running water cutting through or displacing the bottom. A fruitful source of destruction is the careless way in which house drains and other connections are made, and it is doubtless true that many sewers fail by spreading out laterally at the spring line until the crown settles, cracks, and finally falls in. Whatever the cause may be, during the spring of 1881 more than three hundred breaks occurred and were repaired in the sewers, besides basins and manholes. The number during the present year is about the same as usual, as far as can be ascertained. The contract for repairs extends over one year, and includes all breaks which may occur, whether great or small. If a large main sewer should fall in it would be the misfortune of the contractor; hence, it is not to be expected or presumed that he will expend more money than he is obliged to do in the first part of the year, nor that he will expend anything in cleaning out or removing obstructions from the sewers so long as the water continues to run and keep out of sight. The number of sewers cleaned out during the spring of 1881 was 15, nearly all of which were in the suburban districts where sand and gravel are washed in from unpaved or newly paved streets and gutters. The exact location of the sewer cleaned being given, indicates the work in each case to have been limited to a small extent; in fact, the matter of cleaning out sewers in the thickly built-up part of the city is almost absolutely nothing, for in the whole city below Poplar street, embraced in the first and second districts, only four instances of sewers cleaned out is mentioned, although 128 breaks have been mended; and in the fourth district, above Poplar and east of Broad, embracing nearly one-third of the whole sewerage of the city, although 142 breaks have been mended, not one single instance of cleaning out a sewer is reported."

In so far as it is proper to draw an inference from this condition the inference would be, not that the sewers were clean, but that, in spite of their deposits, they still furnished a sufficient water-way. "Doubtless most of the organic and lighter matter is washed into the river in time of heavy rains, but the quantity of heavy rubbish, building waste, paving stones, and sometimes bowlders and pieces of curbstones falling in through the numerous breaks in the sewers are not washed away, and afford a serious obstacle to the flow of water at all times, as well as to the discharge of solid matters, especially from the smaller sewers."

SPECIAL INVESTIGATIONS.

Mr. Baldwin's special examinations at manholes, at outlets, and in the sewers themselves give instructive results:

"There is no system of inspection of sewers in Philadelphia, and few persons have ever been in them except workmen, to make the necessary repairs, and these only at rare intervals, for repairs and corrections are almost invariably made from the outside; hence, the condition of the inside of sewers is unknown, and appears to be uncared for, so long as water turned into them gets away and does not come back to the surface or flow into cellars or basements. When, therefore, anybody proposes to go into a sewer for no other purpose than to find out its sanitary defects and condition, he is met with looks and expressions of genuine astonishment and surprise on the part of the city officials. The first intimation that a sewer is out of order usually is that the street caves in, when the break is mended and the street and pavement restored; but what becomes of the rubbish, bricks, and paving stones that have fallen into the sewer nobody knows or cares. It is supposed, and confidently asserted, that these are washed away by the water, but when one comes to walk through a sewer he learns better, for even in large mains, where there is great rush of storm-water, the heavier rubbish, such as brickbats and paving stones, are met furthest down stream, and behind these accumulate the different grades of pebbles, gravel, sand, and mud, while the slack water backed up behind all shows the deposits still to be in progress. This is observable, among other places, in the large main sewers in Huntingdon, Amber, and Sergeant streets, near the Frankford road, where the deposit of coarse gravel, sand, and stones is about two feet deep in a sewer 7 feet diameter, having a strong flow of water, abundantly sufficient to keep the sewer clean under reasonable circumstances. A similar instance may be mentioned in the Cohocksink sewer, in Randolph street, sometimes called Mifflin street, from Thompson to Columbia avenue, especially in the vicinity of Master street, where piles of paving stones, bowlders, and curbstones form a dam high enough to set back the water for several hundred feet. If this be true in the great mains, one can expect to find it still worse in the small branches, where the flow of water is too small to carry away even the lighter obstructions of sand and gravel. A branch sewer in Emerald street, below Lehigh avenue, recently opened to connect a sewer from Elizabeth street, was found half full of bricks and coarse rubbish. Where the flow is rapid and strong, these obstructions throw the water into violent ripples, eddies, and waves, having a tendency to destroy the masonry and cut away the bottom, while, if the flow is moderate, they back up great deposits of sand and organic matter, to decay and render sewers foul and filthy beyond all description. Among the great sewers, or underground rivers, of Philadelphia, may be mentioned the one, 16.5 feet in diameter, known as Hart Creek sewer. * * * Like the other great sewers of this kind, it receives the stream directly, without provision to keep out drift, wash, and rubbish during freshets; hence the bottom of the sewer is covered with gravel, cobbles, bowlders, and great stones to a depth of 3 feet or more, forming a bed precisely like that of the creek in the open water-way above, and the stream winds around among rocks, shoals, and sand-bars as if it were running in the open air, and not in a great sewer. The bottom is so covered for a distance of about 3,500 feet. The depth of the deposit and size of the rocks and stones diminish as the distance increases."

"When the bottom of the sewer is not covered with stones and gravel it is exceedingly rough, from the waste cement and brickbats dropped by the workmen and never cleaned out. These have formed mounds and points projecting sometimes a foot or more high, and as solid as a rock. In one instance a pile of rubbish was mistaken for a dead horse, which it very much resembled in size and shape, but was found to consist of bats and bricks and cement as hard as stone. In several instances a tub of mortar had been thrown down and left to harden. * * *

"Blocks of wood and pieces of timber left by the workmen in the well-holes, only 5 or 6 feet above the bottom of the sewer, have not been carried away, and the little sticks, straws, &c., clinging to the brick work, do not appear above the middle of the sewer. * * *

"Other great sewers of Philadelphia are in substantially the same condition as the one just described. An examination of the large flat-bottomed sewer in Germantown, built to carry a stream known as the Wingohocking Creek, showed the bottom to be amply protected from the action of running water by the heavy deposit washed in, consisting of stones, gravel, mud, branches of trees, and all manner of rubbish. * * *

"Access to the interior of most of the sewers is not very convenient, as there are no ladder bars in the manholes, and one has to be let down by a rope and lifted out again in the same way. An attempt to enter the Huntingdon street main from its mouth under the bridge over the Aramingo canal failed, for the whole bed of the canal is covered with a deposit of soft mud, in some places 2 feet deep, and in others apparently bottomless. The water overlying this black mud is filthy beyond description, and the bubbles of gas arising from it, especially when disturbed, pollute the atmosphere all around. A

line of water-pipe has recently been laid along the middle of Huntingdon street, passing directly through the manholes of the sewer, hence making the means of access all the more limited. * * *

"Above Trenton avenue and in the vicinity of the Frankford road are large piles of brick, gravel and paving stones left in the sewer when repairs were made some years ago to a part which fell in. These accumulations of rubbish have held back deposits of gravel, sand, and mud, and have backed up the water to a depth in some places of 2 feet or more. The accumulations of sand and gravel are very irregular, and the water running over the surface has made them so compact and solid that they will probably remain until removed by some means other than the natural flow of the water. An instance was observed in the inside of this sewer where a house drain 10 inches diameter terminated in a cast-iron hinged valve or cover intended by its weight to close against the house drain and exclude sewer gas and prevent the back flow of water if the sewer should become full. It was entirely useless for either purpose, as such mechanical contrivances often are, for the cover had caught obstructions from the interior of the drain and was wedged open about two inches; hence it served as an obstruction to the outflow without accomplishany good purpose whatever."

Concerning a main sewer in Palmer street, it is stated that "all attempts to find a manhole between Girard avenue and the river were ineffective; if manholes were ever built they are now concealed, perhaps paved over, but certainly a careful search did not bring any to light. * * * From Girard avenue to Front street there is no difficulty in entering them if one is willing to be let down by rope through the manholes. * * * There is considerable coal, ashes, and cinders also in this sewer, but the most troublesome thing encountered was the foul air and gas. In the upper part of the sewer, near Front street, the accumulation of illuminating gas, probably from some leaky street pipe, became so great that we had to put out the torches for fear of an explosion and walk the rest of the way in the dark. * * *

"Attempts to enter the sewers in the manufacturing districts of Philadelphia are useless at any time except nights or Sundays, on account of the discharge of steam and hot water, and even at such times an entrance is attended with considerable risk and danger and can accomplish nothing, for the steam fills the sewers so completely that no careful inspections can be made. Thinking that current reports might be somewhat exaggerated, an attempt was recently made to go up the Cohocksink Creek sewer in a boat, from its outlet at Laurel street. No inconvenience was experienced below the Frankford road. The outlet of the sewer is built of stone and is in good condition, but near the Frankford road the discharge of steam became so thick and heavy that no further observations could be made, and before reaching Front street two steam pipes were encountered discharging from opposite sides, and the roar and noise was so great we could scarcely hear each other speak, while the heat and suffocation was so great that the men declined to go further for fear of being scalded by the jets of steam and hot water which it would be impossible to avoid, because the atmosphere was so thick we could see nothing ahead, and could scarcely discern each other. In other places in this part of the city, on lifting the lids of the manholes, the rush of steam was so great that it was manifestly impossible to make any examination. * * *

"In the old sewer known as East Cohocksink, built in Randolph street (then called Mifflin) and Montgomery avenue, the flow of water is less rapid, but is from 10 to 12 inches deep. Considerable obstruction of stones, bricks, paving stones, bowlders, and large pieces of curbstone and building stones obstruct the flow in various places, especially about the old Master street bridge, which is now part of the sewer. In several places, too, the crown of the arch is settled and cracked, and the bricks have fallen out. In other places the sides have washed out, and in one instance both sides had lost the interior shell of brick for a length of several feet. The bottom of this sewer is also washed out in places, sometimes for a length of several feet, and, in one instance, the interior shell of brick was gone for a space of six feet wide and twenty-two feet long (Montgomery avenue, below Seventh street). In some places the water was running over the ground, and in others over the bottom of rock where the brick work was gone. In one place the brick work was destroyed opposite the entrance of a branch sewer, evidently carried away by the force of the water rushing in from the branch. This sewer is 10 feet in diameter and circular, and has a fall according to the plans in the office of 0.42 per hundred. It has evidently been filled full of water. A gas or water pipe passes through the crown of the arch at Columbia avenue, leaving a space of but 6 inches between the pipe and top of the sewer, and this space is filled with driftwood, branches of trees, and a pole about 5 inches in diameter and estimated to be 16 feet long. * * *

"The sewers of Philadelphia are almost absolutely without ventilation, and when first opened, the rush of vapor, gas, and sometimes of steam, is nearly suffocating. After leaving the manholes open a while, this passes off in part, and one can enter with some degree of safety by observing due caution. * * *

"Several things impress themselves very forcibly on the mind of any person on going into the sewers of Philadelphia, among others:

First. The necessity for a system of maintenance and repairs whereby the interior shall not be obstructed with the rubbish, bricks, paving stones and *débris* falling in from the many breaks constantly occurring all over the city, and from the connections made with house drains and for other purposes. It may be assumed that any system of public works worth building is worth maintaining in repair when it is built. That if it is worth while to expend fourteen to fifteen thousand dollars a mile to build branch sewers, it is also worth while to pick up and remove the building refuse and rubbish left in them by the masons and workmen, so that the water may have some chance to flow through when they are done. There are about 200 miles of public sewers in Philadelphia, and in them about 400 to 500 breaks occur every year, or on the average not far from one break per year for every half mile of sewer; hence it seems quite essential that the rubbish and *débris* from so many places should be taken out before the whole system of underground work gets filled up."

"The improved shape and materials used for small sewers in many small cities have not been introduced in Philadelphia, but branches are still constructed precisely as they were in the beginning. This defect is very noticeable in the observations recently made, where in many instances the water now meandering over the surface of sand and mud in the bottom of a 3-foot circular sewer is amply sufficient, if contracted in a narrow channel of a sewer of improved shape and smooth surface, to shoot along like an arrow down the grades and rapid descents usually found in most sewers, and would be discharged into the river in less time than is now wasted in trickling away through a distance of a square or two, and at the same time would carry with it many tons of matter now left stranded along the way until washed out by storm-water, and some not even then. But even in their present shape, a system of regular inspection and cleaning out of the coarser obstructions would greatly improve the condition of the sewers in almost every place where they have been examined.

"Secondly. The sewers of Philadelphia are obliged to carry almost everything which a great population wants to get rid of. Probably it is quite unavoidable that much kitchen waste, garbage, and swill should find its way into the sewers, but there seems to be no good reason why they should be filled up with ashes and cinders, cast-off clothing, boots and shoes, broken dishes and glass, nor why they should be expected to carry off the waste offal and entrails from slaughter-houses and markets, or the steam and hot water from factories and machine shops. * * * Many other matters are pointedly suggested by, and might properly be considered, in connection with the interior inspection of sewers, such as the very apparent need of a better class of workmanship, amply illustrated by the dilapidated condition and appearance of some sewers built not very long ago; the necessity for improved water-way where the flow is so swift and strong as to wash out the bottom of sewers; the need of manholes at more frequent intervals, as they are seldom found nearer than a quarter of a mile from each other, and sometimes even further apart.

"There is almost no provision for ventilation of sewers in Philadelphia. The outlets to the river are so low as to be sealed for several hours at a time when the tide is high. The manholes are closed with close covers, not only tightly fitting, but often so rusted and jammed with mud and street dirt as to be raised with difficulty, and many manholes have been covered and paved over, so that their location is lost, and they can be found only from the inside. The inlet basins are closed with a water seal or trap, intended to make them air-tight, and they are so closed in time of rain if not at all times. House drains usually terminate in a slop-stone beneath the hydrant in the back yard, or are led directly into the interior of the dwellings. The traps of house plumbing are sufficient, usually, to cut off all circulation of air, but are forced the moment any pressure is brought to bear upon them, either by an inflow of water to the sewer, a change of temperature of the sewer air, or any other disturbing influence, hence the dead air of the sewer stagnates, and is saturated with putrescent matter and organic germs, until its condition becomes not only indescribable, but unknowable, and this most deadly of all imaginable compounds is separated from dwellings, kitchens, and, too often, sleeping apartments, by a few drops only of dirty water lying in what is commonly known as a trap. These few drops or spoonfulls of water, if standing quietly at rest, allow the vapors to pass slowly through as if through a piece of sponge, and finally evaporate or leak away entirely. If water is poured down the pipes the gas bubbles up through, while if there is the slightest pressure from any cause, the seal is worthless. A trap holding water 2 feet deep would resist a pressure of only one pound per square inch, while the ordinary trap, holding about two inches of water, would only resist a pressure of one ounce per square inch. Any disturbing influence in the interior of the sewer, whether caused by a rising tide, an unusual flow of water, a change of temperature, or any other of the many causes likely to occur at any time, forces the sewer air directly into the houses, while if the slight body of water in the trap evaporates, or is sucked out by a flow of water in some other part of the house, as it often is, then a direct communication with the sewer is opened, and the air circulates through in a constant flow. In view of these considerations, well known but seldom thought of, and not often mentioned, the necessity for some system of ventilation of the

public sewers is perhaps the most important thing to be considered in discussing the sanitary condition of the sewerage of Philadelphia. Let any person raise the lid of a cover over one of the public sewers and attempt to look down, and he will be convinced of the need of ventilation without further argument. In fact it is only necessary to observe the offensive odors coming from the inlet basins in many places, or even sometimes observable in the middle of the streets above some of the great sewers, as at Broad and Arch, Tenth, below Market, Twelfth, from Vine to Callowhill, to be convinced of this same fact."

THE DRAINAGE AND SANITARY CONDITION OF HOUSES.

The examination made of the system of house drainage in Philadelphia discloses the wide extension of a system which has long since been condemned by all sanitarians. It seems of sufficient interest to be given without abbreviation:

"Portions of the city somewhat removed from the center, and not supplied with water-pipes and sewers, usually derive their supply of drinking water from deep wells, and turn the waste into cesspools, both located on the same lot; and, consequently, not very far apart. As the city water supply is extended, and the population becomes more dense, and the plots of ground are divided into lots of smaller size, the wells, as a source of drinking water, have to be abandoned, but not so the cesspools. On the contrary, the well once supplying good water, but now useless for that purpose, affords the most convenient means of disposing of the wastes from the house, having been excavated far into the water-bearing strata underlying the city. It is often remarked that the water of a spring or well will not rise above its source. It is equally true that by pouring in more water, a well cannot be filled above its outlet. The great underground flow will receive and carry off an amount practically unlimited. Not only is this true of clean water, but even when containing a large proportion or matter susceptible of fine mechanical subdivision, the large supply of fresh water will so dilute and wash away the solid matter that many years pass by before accumulations begin to fill up the well. Even then, as the surface of the deposit rises, it meets the adjacent layers of soil not yet saturated, which allow liquid matter to pass away. The experience thus gained has induced many householders to excavate cesspools deep below the water-bearing surface, so that in many parts of Philadelphia these cesspools, now almost universally called wells, probably from their origin, extend to a depth of 20 or 30 feet, and even sometimes many more feet below the surface of the ground. Originally these wells are located in some out-of-the-way part of the lot in rear of the dwelling, but as the city grows, and new houses are built and streets opened, it is more likely than not that the rears of large building plots become the fronts of smaller lots, facing on a new street laid out between two old ones. Some of these squares of the original city of Philadelphia now have two or three intermediate streets laid out through them. These old wells, dug for drainage purposes, are so deep as to be far below the level of the cellar bottoms of adjacent houses. It would be very uncharitable and probably untrue to say that wells are ever dug within the walls of a dwelling house, but it is true that a house is sometimes built over an old well, and, instead of its being cleaned out and filled in, it is still used to receive the drainage of the new house. The location of the pipes leading into the well from the old houses, too, are forgotten, and unless they happen to be uncovered and cut off in digging for the foundation of the new one, the underground drainage of an area once forming a plot of considerable size, owned and occupied by a single family, is now so complicated and forgotten that nobody knows or cares anything about it. Such old forgotten house drains are frequently found in rebuilding old houses, and in extending the foundation to a greater depth than before. The earth beneath and around them is usually discolored for a distance of several feet in all directions from the drain. An instance of this kind was observed only a few days ago in the excavation for the foundation of a house being rebuilt on Market street. below Eleventh, where an old drain was cut off, exposing a considerable extent of black and green-colored clay beneath the level of the old foundation. In excavating for the foundation of an extension of a dwelling on Twelfth street, not far from Vine, two old wells were uncovered directly in the line of the foundation walls, and only 12 to 15 feet apart. As they were filled with a black, soft, oozy matter, and were apparently bottomless, the usual practice common among builders was resorted to, viz, to turn an arch over the well to sustain the wall of the house above it, and let it remain, disturbing the contents of the well as little as possible on account of the sickening stench given out when moved. An example of a well entirely within the walls of a house, and still used to receive its drainage, was observed, not long since in the cellar of a house on Race street, below Twelfth; workmen were cleaning out the deposit of black, greasy putrescent matter, having first dipped out the liquid matter in buckets and poured it into the street gutters. After emptying the well, the workmen measured its depth with a tape line and pronounced it to be 27 feet deep below the board floor of the cellar, and said it extended to gravelly bottom and was walled up with brick. It might be presumed that, as the sewerage is extended, householders would make sewer connections at once and dispense with the cesspool or privy well, but this is seldom true. It is only when the soil about the well becomes so saturated that it will no longer allow the liquid contents to soak away, and hence the frequent visits of the scavenger becomes troublesome and expensive, that any remedy is sought, and then the first step in improvement usually is to lay an overflow pipe from the well so that when full the liquid contents may run over and discharge through the pipe into the street sewer. Of course, in such cases, the well continues to retain considerable solid matter until its surface rises above and closes the outlet pipe. To diminish the accumulations of solid matter, the householder is advised by his plumber to turn in the rain-water from the roof to get the benefit of a large quantity of water at intervals to wash out and clear the overflow pipe, and at the same time dilute the sediment and wash as much as possible of it into the sewer. This method of drainage is a gradual development, as will be seen from the foregoing notes, and one might think it would be found only in old houses where the owners put off a complete arrangement on account of cost and inconvenience of pulling things to pieces and building anew. But the practice is not confined to old houses, for so great is the tendency on the part of workmen, builders, and plumbers, and even architects, to do work in the manner they have been accustomed to, that many blocks of houses built recently and even now in process of construction (May, 1881) are drained in precisely the same manner. The accompanying sketch, page 8, made by observations on the ground, illustrates the drainage of a block of twelve houses now building on Lehigh avenue, near the Frankford road, where the drainage from the house and the rain-water from the roofs lead to privy wells in the rear, each serving for two tenements, and being all connected by branches to one outlet pipe, laid even with the bottom of the well and connecting finally with the street sewer. Wells are about 7 feet deep, circular in form, and walled up with a 4-inch ring of brick, laid dry. They have no bottom but the ground. This is given, not so much to illustrate the drainage of this one block of twelve houses, as to show the arrangement of houses of that class which are usually drained on the same principle. These houses are 14 feet front on the st eet, two stories high, and will probably rent for from $14 to $16 per month. Houses of a more elaborate style, having interior water-closets and bath-room conveniences, are drained in substantially the same manner where a back street or alley affords drainage in the rear, or where a block of buildings belonging to one owner enables a pipe to be laid along the rear of all the lots to make a single sewer connection. In such cases the roofs of houses pitch towards the rear, the rain-water from the front being conducted to the gutter of the roofs on the rear and lower stories, and thence, finally, to the drain-pipe by a leader from the lowest gutter. A hydrant in the back yard, for supplying the drinking-water used in the house, has a convenient slop-stone beneath to receive the waste, as well as the wash from the paved yard, and conduct it to the same drain-pipe. The water-closets and bath rooms have the same outlet; but, for the accommodation of those on the first floor, a privy is built in the back yard, over a vault, which at the same time receives the kitchen slops and overflows into the same main house-drain leading along the rears of all the houses until it finally discharges into the street sewer. The accompanying sketch, page 9, does not represent any particular house, but is furnished by an officer of the health board as an example of one of the most common methods of house drainage where a main drain-pipe along the rear can be secured. Hundreds of houses in Philadelphia are said to be drained according to that plan, many of which are new and some still in process of erection.

"Remarks in the foregoing pages on house drainage have been limited to cases where a main drain can be secured along the rear of dwellings, making a single connection with the sewer. This is frequently possible in Philadelphia, both on account of the narrow streets and alleys so often cut through the squares in the thickly populated districts, and also from the fact that in so many instances a whole block of houses is built and owned by a single person, building association, or company. The interior arrangement of Philadelphia houses is such that the bath-rooms are usually in the center or rear of the building, and the kitchen is in the rear, on a level with the parlor floor, basements being the exception rather than the rule. When, therefore, it becomes necessary to conduct drainage from the rear to the front of a house and thence to the street sewer, it is almost invariably done by means of a terra-cotta or ordinary clay pipe laid in the ground beneath the cellar. These pipes laid beneath the cellars are often of size entirely disproportionate to the duty required of them, being 8, 10, or even sometimes 12 inches in diameter, for a single building. The explosion of gas in a sewer on Master and Philip streets, already referred to, afforded an opportunity to observe the method of drainage in that locality, which is said to be in accordance with the usual practice. The elements of the system may be briefly stated: The position and depth of pipes beneath the cellar could be noted, as they were blown up by the explosion. A privy-vault in the back yard serves to accommodate the occupants of the house, or to receive the drainage from water-closets, if any, in the upper stories. The vault is washed out by rain-water led to it from so much of the roof as inclines toward the rear. A terra-cotta or earthenware pipe from 8 to 12 inches in diameter serves as an overflow to carry away the liquid contents of the vault, passing under the cellar, buried about one or two

feet in the ground. The waste-pipe from the sinks on each floor connects with and discharges into the main drain-pipe beneath the cellar. A hydrant in the back yard affords a supply of water for all purposes, principally for the laundry, which, in the summer season, is usually in the open air. Beneath the hydrant is a slop-stone with an iron grating, through which the waste from the hydrant, the drainage from the yard, and the water from the wash-tubs pass under ground to the same house-drain beneath the cellar. This is the common practice of drainage where houses present a solid front on the street and have no means of drainage to the rear. It may be seen in much of the older part of the city, especially in the district named, and in fact all along the Delaware front below Fourth street, and elsewhere.

"Such houses afford no access to the back yard except by passing through the house, and that is very inconvenient; besides, it does not admit of the occupation of back yards by building rear dwellings in them. To avoid the inconvenience, many blocks of buildings are furnished at intervals with a passage-way between the houses, usually not more than one story high, the second story of the house extending over and forming a continuous floor. The passage-way serves as an outlet for two back yards, and, if wide enough, the division-line fence extends through the middle, affording a separate entrance for each property, often closed at the street with an iron or other open-work gate or door-way in the better class of houses. Sometimes the passage-way is too narrow for that purpose; in fact an instance was recently observed in a street running from Twelfth to Thirteenth streets, below Vine, where the passage-way was not more than 2 feet wide. Such a passage-way serves a double purpose, for it not only allows people to walk through without entering the house, but also, being paved with brick laid in the form of a shallow ditch, it allows the drainage to run through from the back yards across the sidewalks to the street gutters. It seems to make little difference if a street is sewered or not; the surface drainage is used all the same in the older parts of the city. The water thus brought out on the surface consists of the waste from the back yards, hydrant, the slops from the kitchen-sink, and the water from wash-tubs, as well as the surface drainage of the back yards and the rain-water from the roofs. Sometimes, after finishing a washing and emptying out the tubs, the careful housewife or servant will turn on the water from the hydrant and sweep out the back yard and passage-way until it presents as neat and cleanly an appearance as possible under the circumstances, but no ordinary amount of washing or sweeping will prevent such surface-drains from giving out foul odors in hot weather, especially where used by several families or taking the drainage from rear tenements located in the back yards and having no other outlet to the street. See diagram, page 10.

"Reference has already been made to narrow alleys extending through the blocks from one street to another. These form a common outlet for the back yards and often conduct their drainage on the surface, being paved in the form of a shallow ditch. Besides the alleys there are many miles of streets only 25 feet wide and sometimes much narrower, built up with a solid row of houses on each side, used as dwellings and cheap boarding and lodging houses. A very common way of laying these narrow streets is to have a narrow strip of cobblestone pavement in the center, with a gutter on each side, and so arranged that the wheels of a wagon will run in the gutters while the horse travels along the paved center. A curb-stone and brick pavement form a sidewalk on each side not over 3 feet wide, sometimes less. Even these narrow streets often serve as a line of departure from which still narrower alleys and lanes branch off, and it is difficult to ascertain at what limit an opening between two blocks of houses ceases to be a street, or where the limits of human habitation are reached. The houses in the crowded back streets and alleys are occupied by the same class of people that inhabit tenement-house districts of other cities. Little is known of these crowded districts, except as one may observe by looking or walking through them. Landlords build houses in any shape and arrange them so as to get the greatest possible income from the least possible investment.

"There has been in former years, and probably is now, a law that no street in Philadelphia shall be made less than 25 feet wide; but one need only walk through almost any part of the old city to see that this law has become as dead as the men who enacted it. It is claimed by most persons in Philadelphia that there are no tenement houses in the city. Perhaps this opinon prevails in part because it is a desirable one to maintain, and in part because there are so few persons who take interest enough in such matters to inform themselves. A diligent inquiry has failed to discover the existence of any sanitary, hygienic, or other society or association intended to discover or improve the condition or character of the houses offered by landlords for rent to the poor. It is well known to officers and inspectors of the health department that hundreds of large buildings, once the residences of wealthy and aristocratic citizens, have passed through the usual stages of the fashionable and unfashionable boarding-house, the cheap lodging-house, and now differ from the ordinary tenement house only in name. The most crowded portions of the city are along the Delaware side, below South street, and again above Vine, where the average density of population by wards is from 100 to 150 per acre, as will be seen by the following table, the population given being for the year 1880.

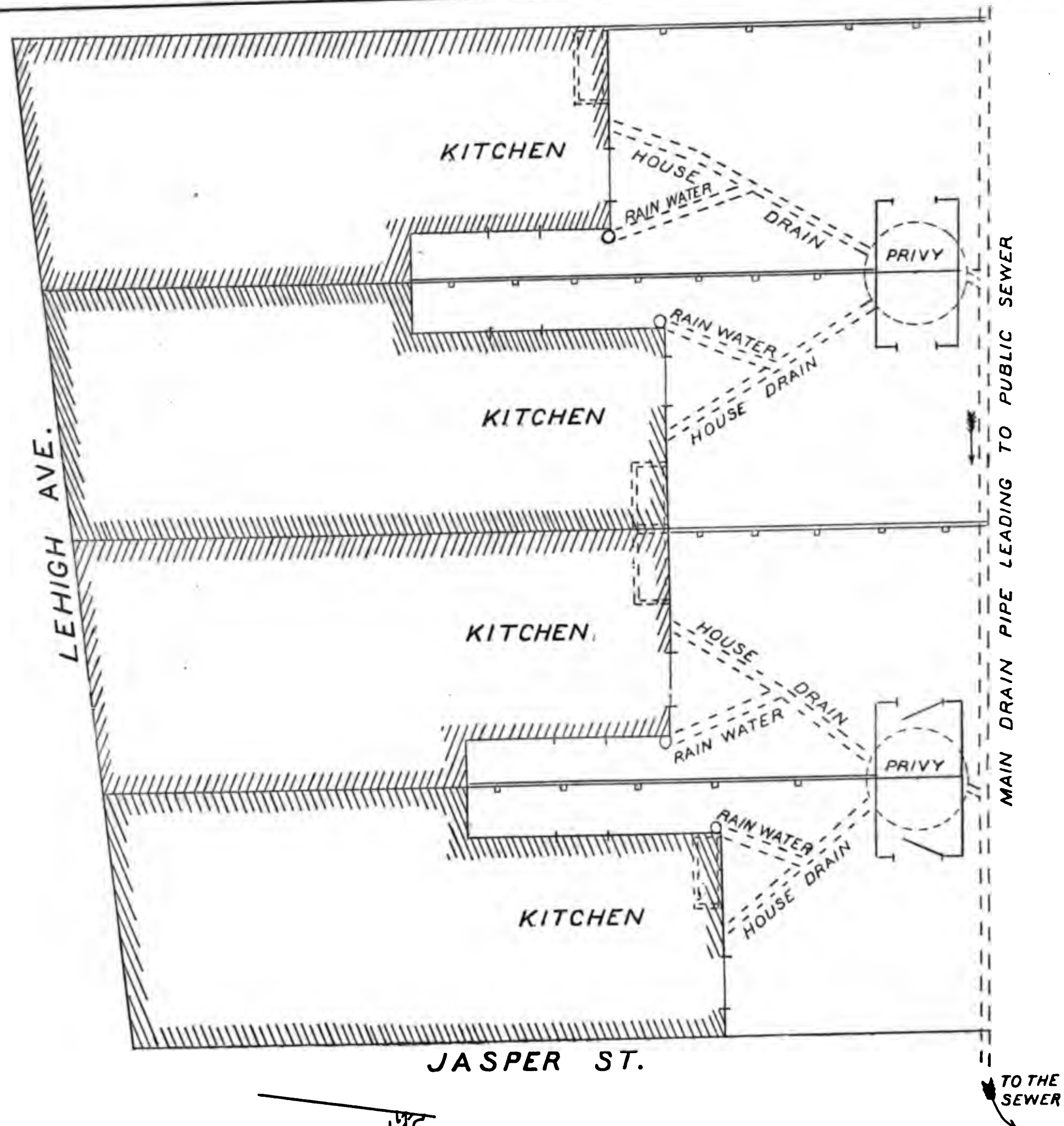
Wards.	Area in acres.	Average per acre.	Total.
2	263.0	108	28,527
3	128.2	143	18,279
4	123.4	153	18,864
7	248.0	126	31,310
11	248.6	111	12,942
12	115.0	127	14,694
13	161.4	115	18,690
14	192.5	114	22,359
15	608.0	80	47,873
16	145.0	123	17,802
17	151.4	135	20,452

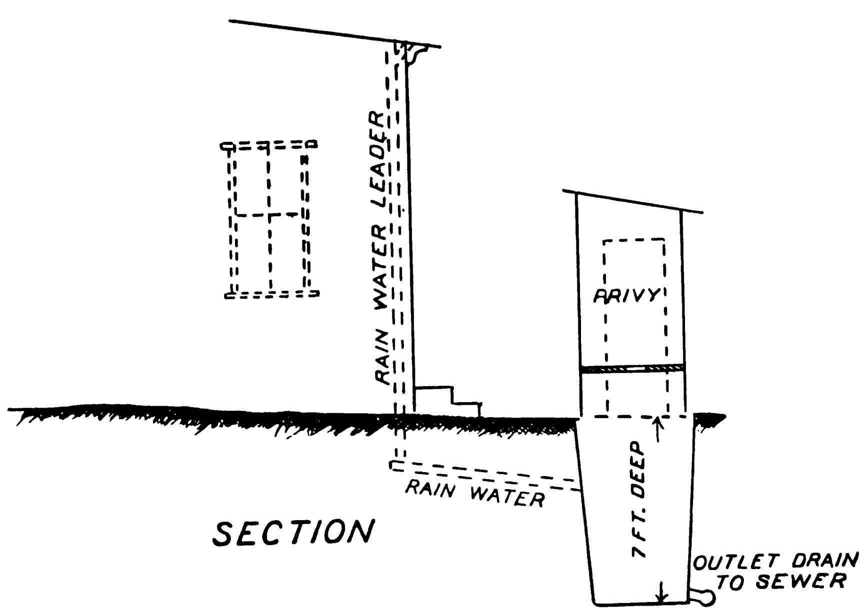
"The greatest population in any one ward, in proportion to its area, is in the Fourth ward, situated between South and Fitzwater streets (two squares), and below Broad street, where the average density is 153 per acre, while in the upper wards, the Twelfth, Thirteenth, Fourteenth, Sixteenth, Seventeenth, in the vicinity of Willow, Girard avenue, and Thompson street below Broad, a district usually regarded as densely populated, the average per acre is from 111 to 135, a population not more than half so dense as in some parts of New York. The disposition of Philadelphia to enlarge its boundaries and take in the surrounding suburban and farming regions of Pennsylvania, with its towns and villages, has developed a tendency to spread out and cover great areas with low, small houses. This has been further encouraged by the naturally level surface, easily converted into streets and covered with cheap pavements of cobble and cheaper sidewalks of bricks. Contractors and builders have not been slow to take advantage of the situation, and building associations have been formed and co-operative systems introduced, until that part of Philadelphia now covered more or less densely with large blocks of such houses occupies an area of many square miles. Mention has already been made of a disposition to enlarge the exterior surface of houses by re-entering angles, court-yards and area-ways, and by cutting narrow streets and alleys through the squares to afford access on all sides of houses, both for entrance and for drainage purposes. This is still further increased by constructing dwellings in pairs, with a passage-way between. The passage-ways observed and described in the older and more crowded part of the city, where they are but one story high, are in the up-town regions extended upward through the entire building, or, in other words, the blocks of houses are cut up in pairs, each pair consisting of two dwellings, with hall-ways and front doors together in the center, and separate side entrances between the buildings, the houses for this purpose being about eight or ten feet apart. Hundreds of such houses may be seen in all the up-town parts of the city, especially on Broad, Fifteenth, Eighteenth, and Twentieth streets, above Master and Oxford, and also in West Philadelphia and in other parts of the city. A block of such being now erected on Nineteenth street, above Master, may be taken as an example. See diagram, page 11. Of course, in districts still farther out of town, as at Tioga and Germantown, the distance between houses is greatly increased, but even there the tendency to build in pairs is very noticeable. This arrangement of houses affords peculiar advantages for drainage and ventilation, and may be regarded as a type of the almost universal practice of building in Philadelphia among the better class of houses. Whether the space between the houses actually divides the block into separate dwellings or extends but a story high, it affords in either case a very convenient means of drainage without laying pipes under the house. It will be observed that the system is the same if the drainage be conducted beneath the surface in pipes, or if the water from the roofs and kitchens be allowed to flow on the surface, as it often is. It is a matter of opinion in Philadelphia which is to be preferred, to turn sink-water on the paved court-yard and alley-way along the surface of the ground, or to pour it into the privy-vault and thence by an overflow to the street sewer. Both methods are practiced and both have been described in the preceding pages.

"There is a strong popular prejudice in Philadelphia against connecting dwellings directly with the sewers, doubtless caused or encouraged by the bad atmospheric condition and entire absence of ventilation of the public sewers. But, on the other hand, the custom almost universally practiced of turning sink and slop water on the ground, allowing it to flow across the sidewalks and stagnate in the street gutter, has such a pernicious influence upon the atmosphere that one feels an indescribable sense of relief on going to the park or moving out of town, where the air is not laden and polluted with the fœtid vapors and foul odors everywhere prevailing in Philadelphia.

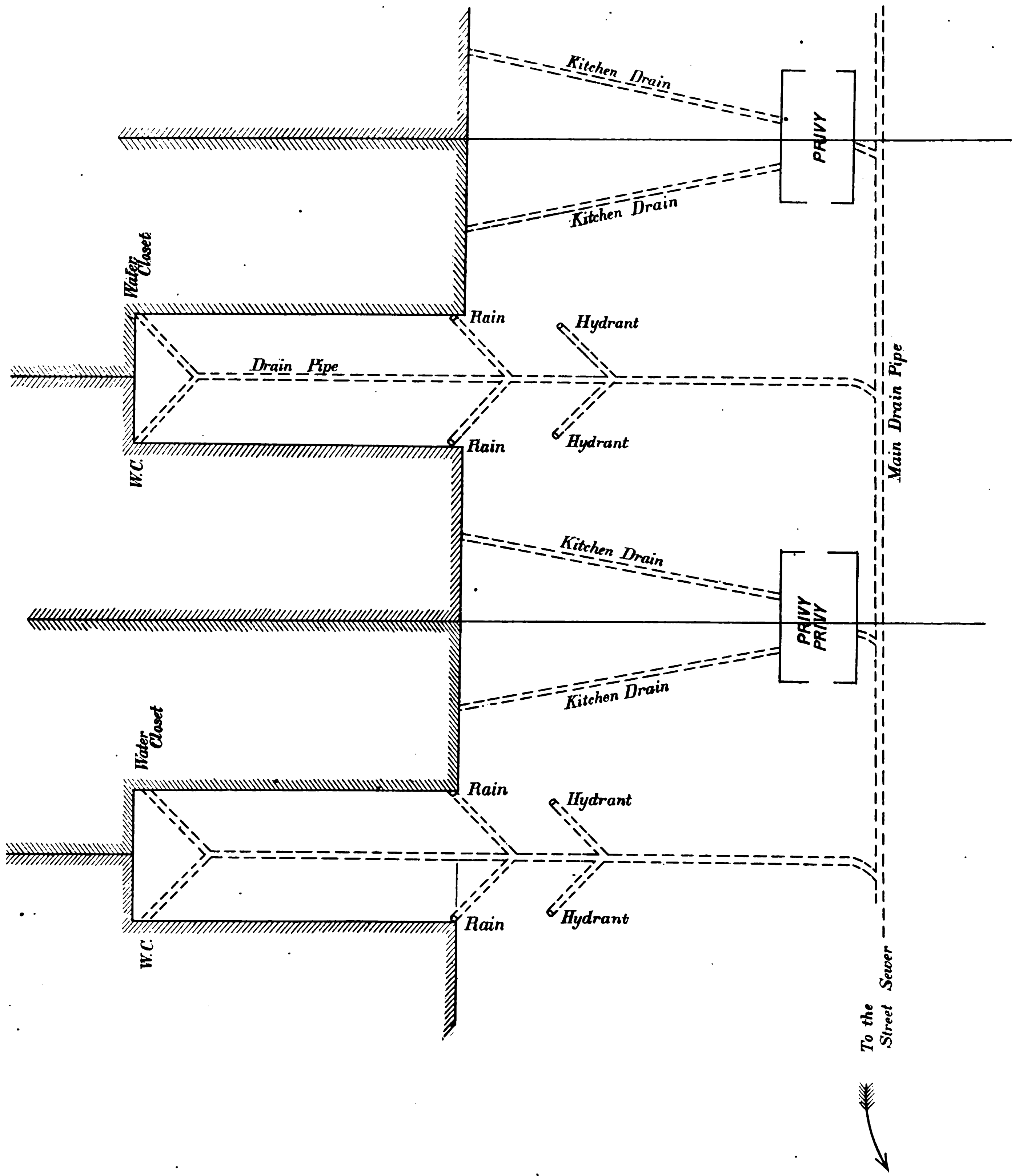
SEWAGE DISPOSAL AND VAULT EMPTYING.

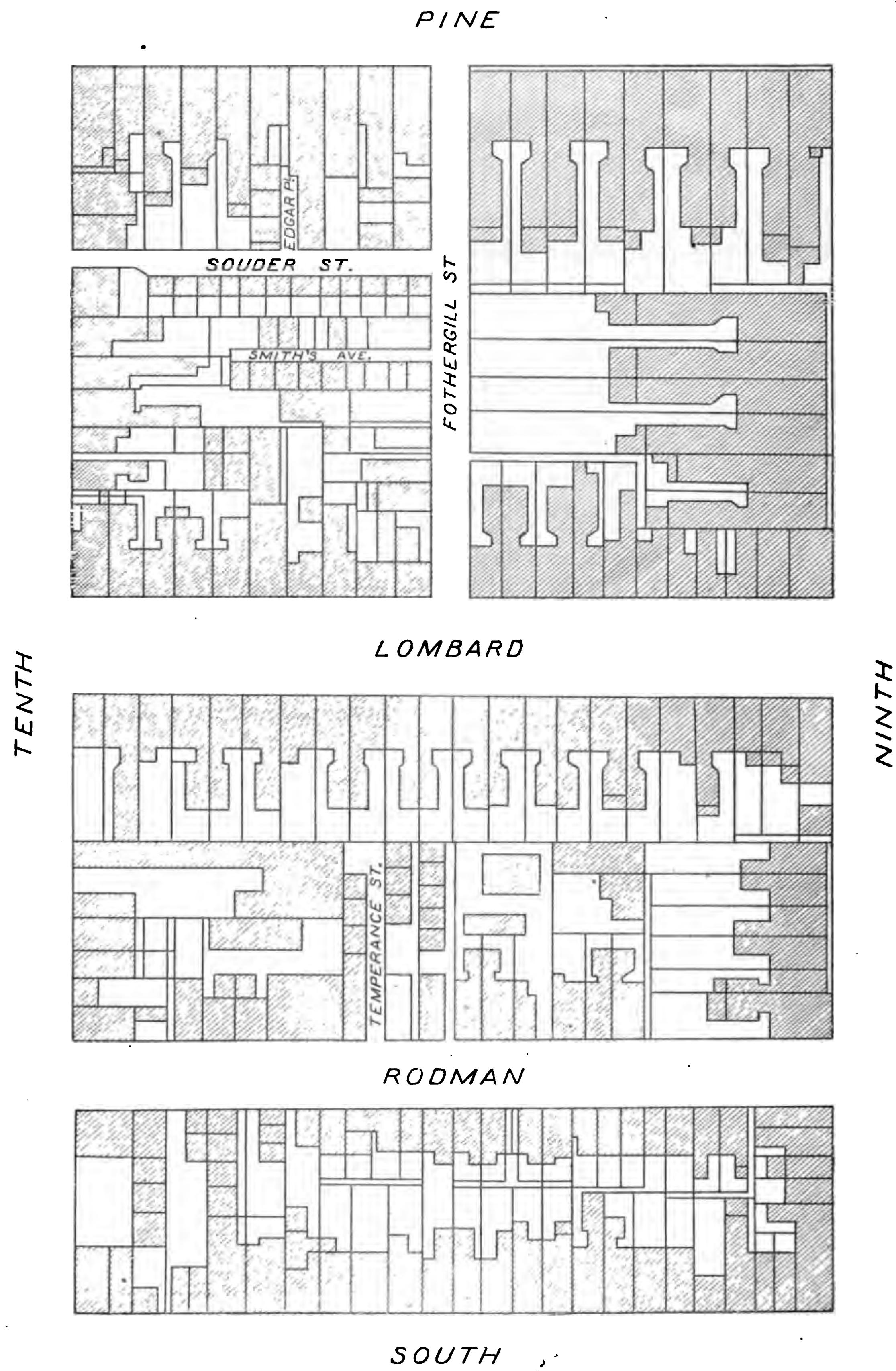
Since 1876 it has been unlawful to remove the contents of any privy-vault, sink, or cesspool within the city limits, or to transport the same through any public thoroughfare, except by air-tight ap-


KITCHEN
HOUSE
RAIN WATER
DRAIN
PRIVY
RAIN WATER
HOUSE DRAIN
KITCHEN
LEHIGH AVE.
KITCHEN
HOUSE
DRAIN
RAIN WATER
PRIVY
RAIN WATER
HOUSE DRAIN
KITCHEN
JASPER ST.
MAIN DRAIN PIPE LEADING TO PUBLIC SEWER
TO THE SEWER

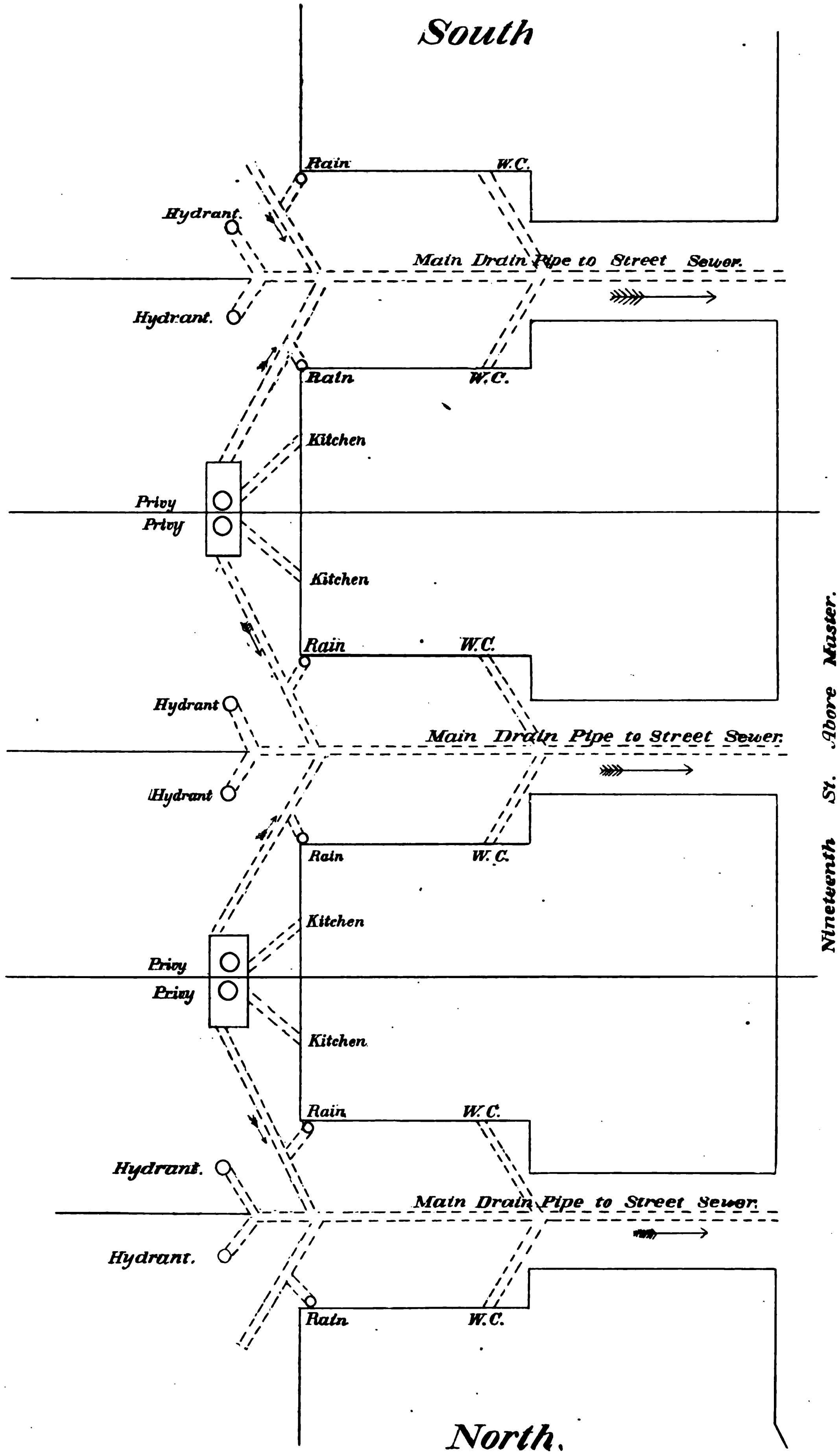

RAIN WATER LEADER
PRIVY
7 FT. DEEP
RAIN WATER
OUTLET DRAIN TO SEWER

SECTION


Kitchen Drain
PRIVY
Kitchen Drain
Water Closet
Rain
Hydrant
Drain Pipe
Rain
Hydrant
W.C.
Main Drain Pipe
Kitchen Drain
PRIVY
PRIVY
Kitchen Drain
Water Closet
Rain
Hydrant
Rain
Hydrant
W.C.
To the Street Sewer



PINE
EDGAR PL.
SOUDER ST.
SMITH'S AVE.
FOTHERGILL ST
LOMBARD
TENTH
NINTH
TEMPERANCE ST.
RODMAN
SOUTH


South
Rain
W.C.
Hydrant.
Main Drain Pipe to Street Sewer.
Hydrant.
Rain
W.C.
Kitchen
Privy
Privy
Kitchen
Rain
W.C.
Hydrant
Main Drain Pipe to Street Sewer.
Hydrant
Rain
W.C.
Kitchen
Privy
Privy
Kitchen
Rain
W.C.
Hydrant.
Main Drain Pipe to Street Sewer.
Hydrant.
Rain
W.C.
North.
Nineteenth St. Above Master.

SUPPLEMENT No. 19,
National Board of Health Bulletin.

WASHINGTON, D. C., SATURDAY, MAY 27, 1882.

PRELIMINARY REPORT ON THE RESULTS OF AN INVESTIGATION, MADE BY DIRECTION OF THE NATIONAL BOARD OF HEALTH, AS TO THE CHEMICAL METHODS IN USE FOR THE DETERMINATION OF ORGANIC MATTER IN POTABLE WATER.

[By Prof. J. W. MALLET, F. R. S., University of Virginia.]

This research was undertaken in compliance with the instructions of a letter from the President of the National Board of Health, written on behalf of the Executive Committee of the Board, and dated Washington, December 29, 1880.

A full report on the objects, in detail, of the investigation, on the methods employed, and the results obtained, has been prepared and placed in the hands of the Board. Pending its publication *in extenso*, the Executive Committee has thought proper to direct that an abstract, covering the principal conclusions reached, shall be published in this BULLETIN. The following pages present such an abstract:

It was intended to examine carefully the chief processes in use for chemically determining the organic matter, or its constituents, in drinking-water, to test the absolute and relative accuracy of the results these processes are capable of yielding, and as far as possible to ascertain the nature and scope of the practical conclusions available for sanitary purposes which may thence be secured.

Three chemists took charge severally of the so-called "combustion process" of Frankland and Armstrong, the "albuminoid-ammonia process" of Wanklyn, Chapman, and Smith, and the "permanganate process" originally suggested by Forchhammer, in the form advocated and minutely described by Tidy. These gentlemen, Mr. W. A. Noyes, Dr. Charles Smart, U. S. A., and Dr. J. A. Tanner, U. S. N., worked independently, the first in the laboratory of the Johns Hopkins University, at Baltimore, by permission of its authorities, the second at the office of the National Board of Health, in Washington, and the third in the laboratory of the University of Virginia. Arrangements were made to have the samples of water for examination collected, and distributed to these three points by myself, so that there should be identity of material submitted to each analyst, and all three analysts should examine their several samples on the same day. Prof. H. Newell Martin, of the Johns Hopkins University, kindly undertook a simultaneous microscopic examination of the waters placed in the hands of the chemists, as also a series of pathological observations on the effect of injecting the waters, concentrated by evaporation at very low temperature, beneath the skin of rabbits, whose temperature and general condition were compared with those of like animals not so treated.

A large amount of preliminary and special work was done in the early part of 1881, the former chiefly with a view to making the analysts thoroughly familiar with the processes to be tested before coming to the actual tests themselves, the latter on various modifications of the processes in detail, and incidental points in connection with them of sanitary interest. From this work a number of results of considerable interest have been obtained, but their publication will have to be made in their place in the general report.

For the main series of test analyses, the following classes of waters were obtained or prepared:

CLASS I.—Natural waters, believed from actual use to be of good, wholesome character, including the regular water supply of some of the principal cities of the United States.

CLASS II.—Natural waters which there seems to be fair ground for believing have actually caused disease on the part of those drinking them. A request for information as to such waters, and for samples of them, was published for several months in the NATIONAL BOARD OF HEALTH BULLETIN, and was extensively copied into newspapers and professional journals, and a copious correspondence with physicians and others in various parts of the country was employed to secure such samples, and to sift the evidence as to the supposed connection of the use of each water with the production of disease.

CLASS III.—Natural waters, of doubtful, but more or less suspected, character. In reference to these the medical evidence was insufficient to justify placing them in Class II.

CLASS IV.—Artificially prepared waters, made by adding to good, wholesome water, determinate amounts of various infusions of *vegetable* organic matter, of natural origin, and of such kinds chiefly as water for human consumption is liable to be brought in contact with.

CLASS V.—Artificially prepared waters, made as above, with various forms of *vegetable* refuse from manufacturing or industrial operations.

CLASS VI.—Artificially prepared waters, as above, made with *animal* (or partly animal) organic matter of natural origin, especially such as are likely to occur in connection with the contamination of drinking-water.

CLASS VII.—Artificially prepared waters, as above, made with *animal* refuse from manufacturing or industrial operations.

CLASS VIII.—Artificially prepared waters, as above, to which had been added morbid products from certain diseases in the human subject.

CLASS IX.—Solutions, in distilled water, of carefully determined amounts of pure substances of definite chemical composition.

The results obtained from the examination of a large number of samples, representing the above classes of waters, are given in detail in a table in the general report. At present the conclusions reached in the discussion of these results can alone be given.

GENERAL DISCUSSION OF RESULTS.

Degree of accuracy of the three principal processes examined.—This may be looked at in two ways: first, as to the concordance of the results obtained by each process in duplicate or triplicate experiments on the same water; and, secondly, as to the agreement of the results obtained with the actual contents of a particular water when these are quantitatively known.

In the former of these aspects we have to do with such errors as are, practically speaking, fortuitous; in the latter we notice especially the indications of constant errors inherent in the methods used.

Extent of concordance of the results obtained by each process in multiplied experiments on the same water.—This has been tested by taking the mean of duplicate or triplicate determinations, noting the difference between this mean and each of the individual determinations on which it was based, and calculating this difference as percentage on the mean itself. The data for such calculation have been most numerous in the case of the combustion process, since it was considered necessary to make duplicate analyses all through the research, with a number of triplicates. It is the more important that this process should be thus examined, in view of the objection which has been often made to it, that it demands an unusual degree of skill and training on the part of the experimenters. In connection with the extensive work of the English Commission on the Pollution of Rivers, it is to be supposed that many duplicate analyses must have been made by this method, but there has appeared but little in print to show how far these were concordant. The results obtained in the course of the present research are summarized in tables XI, XII, and XIII.

TABLE XI.—*Extent of disagreement of results of multiplied analyses of same water by combustion process.*

	Divergence of individual results from mean, *as percentage on mean.*		
	Greatest.	Least.	Average.
For all waters in Classes I to VIII, inclusive, save the few for which there was but one analysis, and those for which there was a known source of error vitiating one of the analyses:*			
Organic carbon	24. 46†	0	4. 24
Ditto, rejecting twelve cases in which the divergence was over 10 per cent. (ten of these cases involved very minute absolute quantities of carbon)	9. 96	0	2. 89
Organic nitrogen	40. 00‡	0	9. 48
Ditto, rejecting thirteen cases in which the divergence was over 20 per cent. (ten of these cases involved very minute absolute quantities of nitrogen)	19. 82	0	7. 09
For the waters in Class IX (solutions of definite chemical substances in known amount):§			
Organic carbon	50. 00‖	. 15	9. 54
Ditto, rejecting six cases in which the divergence was over 10 per cent. (four of these cases involved very minute absolute quantities of carbon)	7. 76	. 15	2. 81
Organic nitrogen	14 52¶	0	5. 05
Ditto, rejecting five cases in which the divergence was over 10 per cent. (but one of these cases involved a very minute quantity of nitrogen)	9. 75	0	2. 71
Average of both the above sets of experiments, giving them equal weight:			
Organic carbon (including all cases)	37 23	. 07	6. 89
Ditto (rejecting in all thirty-six extreme cases, as above)	8. 86	. 07	2. 85
Organic nitrogen (including all cases)	27. 26	0	7. 26
Ditto (rejecting in all thirty-six extreme cases, as above)	14. 78	0	4. 90

* Representing in all two hundred and sixty-two separate analyses for carbon and two hundred and forty-six for nitrogen. (Some analyses for the latter element were vitiated by uncertainty in the determination of free ammonia, and hence in the amount to be subtracted for this latter.)

† Actual difference was less than .3 milligram.

‡ Actual difference was only .04 milligram.

§ Representing in all forty-one separate analyses each for carbon and nitrogen. (One determination for each was without a duplicate, and hence had to be rejected from the data for this table.)

‖ Actual difference was .035 milligram.

¶ Actual difference was .47 milligram.

TABLE XII.—*Extent of disagreement of results of multiplied experiments on same water by albuminoid-ammonia process.*

	Divergence of individual results from mean, *as percentage on mean.*		
	Greatest.	Least.	Average.
For thirteen waters in Classes I to VIII, examined in triplicate:[*]			
Free ammonia	36.05	0	5.91
Ditto, rejecting two cases involving very minute quantities of free NH_3	19.05	0	2.79
Albuminoid ammonia	8.51	0	2.69
For waters of Class IX (twenty-one in all—all examined in duplicate):[†]			
Free ammonia	5.53	0	1.67
Albuminoid ammonia	14.28	0	6.19
Ditto, rejecting four cases involving very minute quantities of alb. NH_3	12.79	0	4.56
Average of both the above sets of experiments, giving them equal weight:			
Free ammonia (including all cases)	20.79	0	3.79
Ditto (rejecting two extreme cases, as above)	12.29	0	2.23
Albuminoid ammonia (including all cases)	11.39	0	4.44
Ditto (rejecting four extreme cases, as above)	10.65	0	3.62

[*] Representing thirty-nine separate determinations.
[†] Representing forty-two separate determinations; of course purely negative results are not included in the data for this table.

TABLE XIII.—*Extent of disagreement of results of multiplied experiments on same water by the per manganate process.*

	Divergence of individual results from mean, *as percentage on mean.*		
	Greatest.	Least.	Average.
For twelve waters in Classes I to VIII, examined in duplicate[*]:			
Oxygen consumed in one hour[†]	4.70	0	1.09
Oxygen consumed in three hours[‡]	4.35	0	.56
For waters of Class IX (twenty-one in all, all examined in duplicate)[§]:			
Oxygen consumed in one hour [‖]	8.33	0	.62
Oxygen consumed in three hours[¶]	6.66	0	1.10
Average of both the above sets of experiments, giving them equal weight:			
Oxygen consumed in one hour	6.51	0	.85
Oxygen consumed in three hours	5.50	0	.83

[*] Representing twenty-four separate determinations.
[†] Including five cases in which divergence was over 1 per cent. (in all these but very little oxygen was consumed).
[‡] Including two cases in which divergence was over 1 per cent. (in these very little oxygen was consumed).
[§] Representing forty-two separate determinations. Of course those are not included in the data for this table, which showed no oxygen, or but a mere trace, consumed.
[‖] Including one case in which divergence was over 1 per cent. (very little oxygen consumed).
[¶] Including three cases in which divergence was over 1 per cent. (very little oxygen consumed).

Of the figures given in the last column of Table XI, those which probably represent with most fairness the average departure from the mean of an individual determination by the combustion process[*] are:

	Per cent.
For organic carbon	2.89
For organic nitrogen	7.09

This goes in part to support the opinion of Tidy[†] that the results of the combustion process are less to be relied on for nitrogen than for carbon.

The results shown for the waters of Class IX are less deserving of attention in this particular respect, since there were but seven different organic substances included, and these specially selected. The reversal of position of the carbon and nitrogen results in this class as compared with the preceding, is partly due to great and variable loss by evaporation of the volatile organic acids, and by dissociation of the salts of the amines, &c.

From the last column of Table XII, the figures which probably may most fairly be taken to represent the average divergence from the mean of a single determination by the albuminoid-ammonia process are:

	Per cent.
For free ammonia	2.23
For albuminoid ammonia	3.62

[*] See Mills' conclusions from a much more limited basis of induction furnished by a few of Frankland's analyses.—Jour. Chem Soc. (Lond.), February, 1878; 58 *et seq.*
[†] Jour. Chem. Soc. (Lond.), January, 1879; 56.

We should naturally expect to find greater irregularity in the evolution of the so-called albuminoid ammonia, though the conditions of chemical action be made as nearly as possible the same.

As regards the averages in the last column of Table XIII, the consumption of oxygen by the waters in Class IX having been for the most part very small, it seems probable that, for practical purposes, the first figures may best be taken, viz:

	Per cent.
For oxygen consumed in one hour	1.09
For oxygen consumed in three hours	.56

showing somewhat greater irregularity in the early stage of the action than later.

It will be seen that on the whole the most closely concordant results were furnished by the per-manganate process, and the least so by the combustion process, the albuminoid-ammonia process holding the intermediate position.

Extent of agreement of the results obtained by the different processes with the quantities of organic constituents known to be actually present.—The detailed evidence under this head is given in columns 19 to 25, inclusive, of the last sheet of Table X, in which the results actually obtained on examination of the waters in Class IX (solutions of known amounts of certain organic substances of definite chemical composition) are compared with the amounts of the organic elements really present and the calculated amounts of oxygen required for their complete oxidation.[*] The following summary (in Table XIV) presents the conclusions reached within the limits of these experiments.

TABLE XIV.—*Extent of agreement of results obtained by the different processes with the known chemical character of the waters in Class IX.*

				Amounts obtained, as percentage upon amounts calculated.		
				Greatest.	Least.	Average.
Combustion process:						
Organic carbon				85.	1.	53.
Organic nitrogen (including that of ammonia)				180.	47.	118.
Albuminoid-ammonia process:	Greatest.	Least.	Average.			
Nitrogen of free NH_3[*]	94.	0.	(28.)[†]			
Nitrogen of alb. NH_3[*]	84.	0.	(24.)[†]	95.	0	53.
Permanganate process:						
Oxygen consumed in one hour				13.	0	3.
Oxygen consumed in three hours:				16.	0	4.

(In this table, as in the last sheet of Table X, a considerable fraction of 1 per cent. is represented by 1—; an insignificant fraction is considered = 0.)
[*] Both calculated as percentage on *total* nitrogen present.
[†] These two averages have no real significance.

The figures of this table strikingly indicate certain important defects of the several processes, although they must be looked at in a broad, general way, remembering the small number of organic substances treated, and their special characters.

As regards the combustion process, we find loss of carbon, in all cases considerable, and in some cases very great; with a strong tendency on the whole to excess of nitrogen, which in some cases is very great. It is of course easy to see how, in large measure at least, these errors were caused for some of the samples. Thus, doubtless, free butyric and valerianic acids were formed from their salts, and volatilized with the water during its evaporation; the salts of the amines probably suffered partial dissociation, with volatilization of the bases; and urea was lost after conversion into ammonium carbonate. It may be objected that such substances as these ought not to have been selected. But it is to be remembered that every one of them occurs among the products of putrefactive decay of albuminoid or other organic matter, and hence may fairly be looked for among the constituents of organically polluted water.[†]

The occurrence of loss of organic constituents during the evaporation of water for the combustion process has often been suspected by the critics of that process,[‡] and often, though sometimes cautiously, denied by its advocates. Thus Mills has said[§]: "Substantially satisfactory evidence has been adduced that there is no material loss during the evaporation." The experiments now reported prove exactly the reverse of this and furnish for the first time, as far as I know, direct evidence of the fact that, for some organic sub-

[*] In this calculation hydrogen has been taken as converted into water, carbon into carbon dioxide, and nitrogen as evolved in uncombined form; of course no one would expect any such ultimate results of oxidation from the action of the permanganate as practically applied. Frankland, in a similar calculation (Jour. Chem. Soc. (Lond.), March, 1868; 83), seems to have taken the nitrogen as oxidized to nitric acid.
[†] Fresenius and Scherer have found butyric and propionic acids in the mineral water of Brückenau and Weilbach. Zeitschrift für anal. Chem., 20; 3; 325.
[‡] Wanklyn asserts in the most positive way the occurrence of loss, but gives no experimental evidence in support of his assertion. (Water Analysis, London, 1879; 190.)
[§] Jour. Chem. Soc. (Lond.), February, 1878; 58.

stances at least, and those of a kind liable to occur among the products of putrefaction, there *is* material, nay, very great loss.

As regards the frequently presented excess of nitrogen, I am strongly inclined to believe it in part at least due to absorption, during the evaporation of the acidified water, of ammonia *from the atmosphere surrounding the gas flame* and water-bath. Due care was taken as to the general condition of the atmosphere of the room, and it hardly seems possible to account for the error from this source.* But any one who has noticed the considerable deposit of ammonium sulphate formed on platinum vessels over an ordinary laboratory lamp, or on bells suspended over household gaslights, will readily admit that here is a manifest source of danger. The extent to which ammonia is removed from coal gas at different works, and in the same works at different times, varies no doubt a good deal, but all American gas which I have examined readily shows its presence. With the gas in use at the University of Virginia and the neighboring town of Charlottesville, I find that when not ignited it will in five seconds produce a distinct yellow stain on a drop of the Nessler reagent upon white filtering paper, and, although no doubt much ammonia undergoes combustion when the coal gas itself is burning, a platinum capsule of three inches in diameter, containing water to keep it cool, will, if held over the flame of a Bunsen burner for half a minute, and the outside surface then washed off into a test glass, yield a liquid which distinctly gives the Nessler reaction for ammonia. During the many hours of the evaporation of a water sample there must occur in the atmosphere about the water-bath a quantity of nitrogen in the form of ammonia which may well be called very large in comparison with the amounts dealt with by the water analyst, and although contact of the contents of the glass dish with this atmosphere is largely cut off by the glass shade, such contact is not entirely prevented, as there is the notch in the rim of the water-bath for the passage of the feed-flask neck. The avidity with which such ammonia as may reach the acid water will be absorbed by it is obvious enough, even though some be afterwards lost by dissociation. The excess of nitrogen observed in the analyses of Class IX seems to be general; even in those cases in which a loss is recorded it will be noticed that this loss is always less than for the carbon of the same substance, and the result is most probably a mere balance between two errors in opposite directions, actual loss of organic nitrogen volatilized in some form during the evaporation of the water, very possibly to even a greater extent than for carbon, and on the other hand absorption of nitrogen as ammonia from the atmosphere.

In reference to the results obtained by the albuminoid-ammonia process, little more is presented than has already been fully discussed in an earlier part of the general report. The total loss of the amine bases by volatilization during the first distillation (with sodium carbonate) results practically, as these bases do not produce the ammonia color with the Nessler reagent, in their nitrogen escaping recognition under the head of either "free" or "albuminoid" ammonia. Here we have a proof that some, at least, of the nitrogenous products of putrefaction are not detected or determined by this process as usually conducted.† There is no discrepancy between the results as to these bases here noticed, and that recorded for a triethylamine salt in Table VII of the general report; in this last mentioned case the salt was in contact with alkaline permanganate from the commencement of the distillation.

The results in this Class IX by the permanganate process have mainly the same sort of interest. It has, of course, long been known that, in the words of Tidy,‡ "there are many substances (most of which are crystalline) that are altogether unacted upon, or very slowly acted upon, by the oxygen of permanganate"; but it has been distinctly claimed for this process§ by the same chemist that "it undoubtedly furnishes us with exact information as to the relative quantities of putrescent and easily oxidizable matter, and of non-putrescent or less easily oxidizable matters, present in the water. The former (viz, the putrescent organic matters) it indicates quantitatively with great accuracy; the latter (viz, the non-putrescent matters) are scarcely capable of the same exact estimation as the former, for they are bodies for the most part of difficult oxidation." Now here we have some of the definite substances which are actually known to occur among the constituents of putrescent albuminoid matter, and it needs but a glance at the table to see how limited is their oxidation by the cold acid permanganate, and yet how considerable are the differences in behavior of these few substances selected mainly on the same general principle.

Of course it is not assumed that the figures in Table XIV really represent either the range of absolute error, or the average amount of absolute error, of the different processes as applied to the doubtless very various forms of organic matter liable to occur in natural waters; these figures do, however, illustrate the existence of sources of absolute error, and by examples taken from the very class of substances which it has been most commonly believed important to detect and determine in water analysis.

Effect on the results by the different processes of varying the extent of dilution of the same organic substances in water.—The evidence in regard to this point is graphically presented in Tables XV, XVI, and XVII. (These tables will appear with the general report.)

In studying these tables, indications of definite effects on the results of the various processes arising from the degree of dilution of the liquids examined soon become apparent, but seem to be subject to much irregularity. Such irregularity, however, is much reduced by a careful consideration of all the circumstances affecting individual cases. Thus, some of the numerical results of analysis ought to be omitted from consideration as vitiated by known errors, as in the case of albuminoid ammonia determinations in obtaining which the whole of the alkaline permanganate was reduced, or an obviously considerable part of the ammonia was still coming off when the process had to be stopped. In other cases the value of the results is rendered doubtful by the solution examined having been excessively dilute or excessively strong; the relatively greater analytical errors for the former, and for the latter the errors of measurement of very small quantities of the liquid itself and greater uncertainty as to its uniformity when turbid, tend to make the figures obtained less trustworthy than when intermediate degrees of concentration were involved; Nos. 110 to 118 inclusive represent the former source of abnormal results, such waters as No. 100 the latter. Again, the three solutions containing each form of polluting material in different degrees of dilution were, as has been explained, necessarily examined on different days, and evidence of changes going on in the mean time are to be found in the relative amounts of free and albuminoid ammonia, the character of the dissolved gases, &c. (see for the latter Nos. 83, 84, 85); hence the *order* in which the three solutions of each group were examined has to be taken into account. Further, the results of one of these tables have often to be considered in their bearing on those of the others, as, for instance, the free ammonia determinations as affecting the value of the figures for organic nitrogen. And, lastly, after having observed the general drift of the errors indicated, we can see in the varying balance of errors of opposite effect an explanation of many apparently exceptional figures.

The general results of such detailed study of individual cases agree with those obtained by a simple calculation of averages, omitting from the calculation such figures as on sound grounds of general principle, are to be regarded as vitiated for the purpose of this discussion. In the following table the solutions of the seven pure chemicals (Nos. 141 to 161) have been left out on account of the abnormal relations of these (which have been separately discussed) to some of the processes. For the combustion process, two other substances, represented by the dilutions Nos. 101 to 103, and 122 to 124, are omitted, because in the former of these the figures for organic carbon are known to be of very little value, and those for organic nitrogen are entirely valueless in consequence of the uncertain determinations of free ammonia present in large quantity (which had to be subtracted from the gross results of analysis), while in the latter the very large amount of the free ammonia correction makes the results doubtful. For the albuminoid ammonia process, those determinations of free ammonia originally marked by Dr. Smart as uncertain (by a ?), have been omitted, and those determinations of albuminoid ammonia in making which the regular charge of alkaline permanganate was entirely reduced, requiring an additional charge to be afterwards added, or dilution to be resorted to. For the Kubel form of the permanganate process one or two cases have been omitted, in which the permanganate was entirely reduced, making the result valueless save as an approximation. Rejecting these obviously worthless data, the averages from all others are given in Table XVIII.

TABLE XVIII.

Average results obtained for different dilutions of same solution of organic matter.

	One-fifth per cent. strength.		One per cent. strength.	Five per cent. strength.	
	Calculated.	Obtained.	Assumed.	Calculated.	Obtained.
Combustion process:					
Organic carbon	20.	17.5	100.	500.	549.8
Organic nitrogen	20.	25.2	100.	500.	372.2
Albuminoid-ammonia process:					
Free ammonia	20.	39.9	100.	500.	445.3
Albuminoid ammonia	20.	27.2	100.	500.	257.9
Permanganate process.					
Tidy method—					
Oxygen consumed in one hour	20.	19.7	100.	500.	475.0
Oxygen consumed in three hours	20.	20.0	100.	500.	468.9
Kubel method—					
Oxygen consumed	20.	19.9	100.	500.	475.9

*The most scrupulous pains, too, were taken to guard against leakage of air into the Sprengel vacuum and nitrogen from the cupric oxide, and errors from these sources could scarcely have failed to be detected. They were examined into over and over again.

† Wanklyn has excepted nitro-compounds and (erroneously) urea, but clearly implies that these are the only exceptions; that the nitro-compounds are without practical importance, and that urea is specially provided for. Water Analysis, London, 1879; 189.

‡ Jour. Chem. Soc. (Lond.), Jan. 1879; 78.

§ Loc. cit., 80.

As regards the combustion process, we find distinct confirmation of the existence of the two forms of constant error which have been pointed out as affecting the evaporation.* The weaker the solution, or in other words, the larger the quantity of water to be evaporated for a given amount of organic matter, the less is the amount of organic carbon obtained, indicating relatively greater loss of this element. On the contrary, the weaker the solution or the greater the quantity of water to be evaporated, the larger is the figure for organic nitrogen, indicating relatively greater gain of this element from the atmosphere, and probably in some cases less dissociation of ammoniacal salts, when the amount of free ammonia found is considerable. If the usual interpretation of Frankland's C : N ratio be applied, the curious and important result of these sources of error, affecting the two elements in opposite directions, follows, that the more dilute an organically polluted water is, the more animal-like in origin will its polluting material seem to be, while the stronger it is the greater will be the tendency to refer the contamination to a vegetable source; this distortion of the conclusions to be drawn from an examination by the combustion process is manifestly in the opposite direction to that commonly assumed to be safe.

In reference to the albuminoid-ammonia process, the weaker the solutions are, the higher are the results obtained, both for free and albuminoid ammonia,† the influence common to both being probably that of imperfect condensation in the distillation, having a less effect as the quantity of ammonia is smaller. As for the albuminoid ammonia, the lower results obtained from the stronger solutions may be partly due to the smaller proportion borne by the fixed charge of alkaline permanganate to the quantity of organic matter to be acted on. The great irregularity in individual analyses is strongly indicative of a varying balance of errors from different sources. It will be observed that the discrepancy between the calculated figures and those of experiment is greatest for free ammonia in the case of the weakest dilution, while the reverse is true for albuminoid ammonia.

The results of the permanganate process are shown to be much less influenced by varying dilution within the limits involved in these experiments than those of the other processes. In the case of the solutions of greatest strength somewhat smaller figures are obtained for the oxygen consumed than calculation calls for.‡ This is probably due to the fact that for the weaker waters the ordinary fixed charge of permanganate added at the first leaves at the close of the process a relatively larger excess than is present when successive additions of the reagent have been made to a water strong enough to reduce the first charge completely.

We must not confound the effect of varying the amount of organic matter in relation to the permanganate by which it is to be oxidized with that of varying greatly, but to the same extent, the degree of dilution of both organic matter and permanganate at the same time. Dr. Tanner's experiments showed that under the latter head a solution of even potassium nitrite might be made so dilute that its action on a correspondingly small quantity of permanganate was rendered very slow.

It may, perhaps, be said in reference to all these experiments on varied dilutions of the same materials, that the several processes under examination are intended for use on water of approximately suitable character for drinking, not on comparatively strong solutions of organic matter, such as many of those I have employed, but the answer to this objection is, that these liquids were taken in order to *exaggerate*, and hence bring to light any defects inherent in the several processes, so far as such depend upon the simple condition of the amount of polluting material in proportion to that of pure water.

SPECIAL CONCLUSIONS AS TO THE COMBUSTION PROCESS.

These may be briefly stated as follows:

1. The combustion itself, carried out according to the directions of Frankland, is a process of great delicacy, and quite satisfactory in its details with proper precautions and in trained hands. There seems to be no advantage in employing any of the various modified ways of determining the gaseous products of combustion which have been proposed instead of gaseous volumetric analysis with the aid of the Sprengel vacuum.

2. The Frankland process is quite within the reach of the manipulative skill of any fairly-trained chemist, but it requires practice, and probably pretty constant practice. It cannot be taken up offhand, and even tolerable results obtained at once. From the hands of a person without proper laboratory training, its results are utterly valueless. It is hence better adapted to regular use in the examination of many samples of water in a large public laboratory than to occasional use by a private individual in now and then examining a single water.

3. The defective point in the process is the failure of the evaporation to leave a residue representing the original organic matter of the water. This, which has been hitherto more or less suspected, has been established as a fact by the investigation now reported on. The process being conducted according to the directions of its authors, there are two constantly-present errors, varying, but usually important in amount, namely loss of carbon,* and gain of nitrogen from the atmosphere, the latter probably partly balanced by loss of that originally present in the water. These errors are relatively greatest when the quantity of organic matter in the water is small.

4. These errors, affecting unequally the carbon and nitrogen, are liable to alter the statement of C : N. ratio,† and hence to distort the sanitary conclusions usually drawn therefrom.

5. The result for organic nitrogen, as obtained by the combustion process, is also affected indirectly by the errors connected with the determination of the ammonia ("free ammonia"), as the nitrogen belonging to this has to be subtracted from the gross result. The existence of such errors, as from imperfect condensation of the ammonia, progressive decomposition of urea and other amides, &c., has been pointed out in previous pages of this report, and will be referred to in the conclusions as to the albuminoid-ammonia process.

6. There is a further indirectly operative cause of error as to the nitrogen, arising from the varying loss of ammonia by dissociation of its salts during the evaporation of the water. Frankland recognizes the necessity of a correction for this, which correction he makes depend upon the amount of ammoniacal salts present, but it is almost certain that the time occupied in the evaporation will also influence the extent of loss by dissociation. Error from this source will in most cases be very small, but may affect to a not unimportant extent the result for *organic* nitrogen.‡

7. The combustion process involves special difficulties in the presence of nitrates, for which difficulties no completely satisfactory remedy is as yet proved to have been found. M. W. Williams' mode of applying the copper-zinc couple for this purpose is deserving of more precise quantitative examination than it has yet received. The simultaneous presence in a polluted water of urea with nitrites and nitrates presents a case of peculiar difficulty involving several sources of error.

8. The formation of sulphuric acid during the evaporation of the water with sulphurous acid seems to be of more frequent occurrence than has hitherto been recognized. Mr. Noyes seems to think that to this source—small amounts of cupric sulphate being formed on mixture of the residue with cupric oxide—may perhaps be attributed the occasional presence, as noticed by Frankland, of traces of free oxygen among the gaseous products of combustion. This occurrence of sulphuric acid in the water residue, even in minute amount, is undoubtedly much to be deprecated, though its effect at any rate on the carbon determinations has not seemed to be as great as might have been expected.

9. The combustion process in its present form cannot be considered as "determining" the carbon and nitrogen of the organic matter in water in a sense to justify the claim of "absolute" value for its results which has been denied to those of all other methods. It is but a method of approximation, involving sundry errors, and in part a balance of errors.

10. There is, however, good ground for believing that in many, perhaps most, cases its results for organic carbon may, with proper precautions, be made more valuable than the indications of the permanganate process, and its results for organic nitrogen in like manner more valuable than the indications of the albuminoid-ammonia process.

SPECIAL CONCLUSIONS AS TO THE ALBUMINOID-AMMONIA PROCESS.

These may be briefly summed up as follows:

1. In the determination of both "free" and "albuminoid" ammonia there is a loss, which may be quite considerable, resulting from imperfect condensation of the ammonia during distillation. This loss varies in amount with the precise conditions under which the distillation is conducted, especially with the efficiency of the cooling apparatus and the time occupied in the process.

2. In the case of waters containing urea, and also other amidated bodies, such as the leucine and tyrosine occurring among the products of putrefactive decay, some ammonia is so easily formed from these substances by boiling with sodium carbonate, or even without this addition, that it is impossible to distinguish sharply between pre-existing "free" ammonia (of ammoniacal salts), and that formed by the action of alkaline permanganate, the so-called "albuminoid" ammonia. This source of error as to the free ammonia reacts, as has been noticed above, upon the result for organic nitrogen by the combustion process.

3. There is no satisfactory evidence in favor of Wanklyn's view

* Compare the results observed by Mills (Jour. Chem., Soc. (Lond.) Feb., 1878; 60) in using evaporating dishes of different diameters. The larger dish gave a rather lower result for carbon, and higher for nitrogen.

† This agrees with Dr. Smart's single experiment on Washington sewage in its original form and diluted. See "remarks" on No. 116 in Table X of general report.

‡ Some indications of a like result may be noticed in a few experiments of Tidy (Jour. Chem. Soc. (Lond.); January, 1879; 80, 81, though the variation in strength of his solutions was not so great, and he himself draws the conclusion that the consumption of oxygen was proportional to the strength.

* In connection with this a number of Dr. Smart's experiments are noteworthy, in which the distillate for free ammonia furnished evidence, by its haziness and greenish color, distinct from that which the Nessler reagent should have yielded, that volatile organic matter was present.

† In Prof. W. R. Nichols' Report on the Boston Water Supply (Fourth Annual Report of Boston Water Board, 1880), variations of the C: N. ratio, extending from a given value to one three or three and a half times as great are observable for the Cochituate water within a few weeks, and still greater variations for the Mystic water.

‡ Examples are furnished by Frankland of analyses in which the ammonia correction is very large in comparison with the organic nitrogen.

that, in distilling with alkaline permanganate, definite and simple fractions of the nitrogen of organic matter are given off as "albuminoid" ammonia. Such results may be varied at pleasure, for most, if not for all substances, by slight modification of the conditions under which the distillation is conducted.

4. If the distillation with alkaline permanganate be carried out as usual, in accordance with Wanklyn's instructions, it frequently happens that the nitrogenous organic matter is so gradually acted upon as to make the ending of the process indefinite; ammonia is still coming off when the distillation has to be stopped in consequence of the contents of the retort being nearly reduced to dryness. In such cases an unknown fraction of the possible amount of albuminoid ammonia fails to be collected, and is but vaguely indicated by the sign + after the figures recorded.

5. There is evidence that in some cases nitrogenous organic matter is volatilized during the distillation for free ammonia, which, if it had been retained, would have yielded up its nitrogen as albuminoid ammonia; not affecting the Nessler reagent, such nitrogenous matter escapes detection under either head.

6. The albuminoid-ammonia process proper, *i. e.*, the distillation with alkaline permanganate and determination of the ammonia evolved, is admittedly simple and easily carried out with very little preparatory training.

7. The value of the results by this process depends more upon watching the *progress* and *rate* of evolution of the ammonia than upon determining its total amount.

8. Taking the results by this process as recorded, we find a good deal of general similarity between the figures for albuminoid ammonia and those for organic nitrogen (by the combustion process), but with frequent discrepancies of varying extent, such as prevent the one being taken as the accurate measure of the other. See Tables XIX and XX, further on.

SPECIAL CONCLUSIONS AS TO THE PERMANGANATE PROCESS.

The chief points worthy of attention are the following:

1. The results obtained by the Tidy method (using the acidified permanganate at common temperature) and by that of Kubel (operating at the boiling point) differ irregularly from each other, the latter usually giving much higher figures, as was to be expected, but the ratio between the results by the two methods varies much in different cases.

2. On the whole, there seems usually to be a nearer approach to proportionality with the quantities of organic carbon* found by the combustion process on the part of the results afforded by the Kubel process than on that of the Tidy results, but to this there are some very notable exceptions. See, on this point, Tables XIX and XX, further on.

3. In a good many instances the results obtained by the Kubel method are, contrary to the general rule, lower than those afforded by the Tidy method. This seems to be due, in all probability, to loss of organic matter by volatilization with the escaping steam from the boiling liquid before time has been afforded for action on the permanganate.† An examination of all the results obtained for Nos. 131, 132, and 133, and several other cases, gives good ground for believing this to be the case. Of course, a similar loss may have occurred in other instances, but not to the extent of reversing the general rule as to the results by the Kubel process being larger than those by the method of Tidy; and this may in part explain the absence of any uniform ratio between the figures yielded by those two modifications of the permanganate process.

4. The results obtainable by the Tidy process are liable to variation with the atmospheric temperature prevailing at the time the process is applied.

5. The amount of oxygen consumed by a specimen of water is probably in all ordinary cases much below that required for complete oxidation of the organic matter present, and does not stand in any fixed ratio thereto; it cannot be taken as a measure either of the organic carbon or of the total organic matter. Nevertheless, a distinct general resemblance may be traced between strongly marked results, high or low, as the case may be, for the consumption of oxygen on the one hand, and organic carbon (by the combustion process) on the other; and closer agreement is observable in regard to waters of generally similar character.‡

6. The permanganate process is capable of giving more valuable information in regard to a water by watching the *progress* and *rate* of the oxidation of organic matter present than by any single determination of the absolute amount of oxygen consumed in a given time.

7. For such observation of the progress of oxidation the two determinations prescribed by Tidy, viz, of oxygen consumed in one hour and in three hours, respectively, are not sufficient, nor is the latter period of three hours long enough to indicate the general behavior of the water with acid permanganate.

GENERAL REMARKS ON OTHER CHEMICAL DETERMINATIONS.

1. The determinations of total solids left on evaporation, of the loss on ignition of this solid residue, and even of chlorine, in the series of varied dilutions of identical or nearly identical liquids, show discrepancies which illustrate the comparative roughness of the methods by which these results were obtained when very small quantities have to be dealt with.* The evaporation of 100 c. c. of water usually left a residue, the absolute weight of which was but a few milligrams, and a very little difference in the dryness attained, or in the atmospheric deposition on the surface of the platinum capsule, involved relatively large errors in the result. Even the volumetric processes for chlorine are far inferior in delicacy to those employed for the organic constituents.

2. As regards the results for nitrites and nitrates, the coincidence seems to be worth noting, which is often presented between alkaline reaction of a water and the occurrence of these salts in considerable or large quantity, suggesting as this does a recollection of the conditions under which nitrates are produced on the large scale in the decay of nitrogenous organic matter. The coincidence, however, is not always observable, nitrites and nitrates ocurring pretty largely in some cases without alkaline reaction, while in other instances (as Nos. 89, 90, and 91, containing the washings from starch manufacture) there was alkaline reaction, and also much nitrogenous matter, but no nitrites or nitrates. Mr. Noyes has drawn my attention to the fact that in the waters containing large amounts of nitrates, ammonia appears in but small proportion; hence ammonium nitrate seems to be rare, the basis constituent being rather for the most part non-volatile—no doubt calcium, magnesium, or one of the alkaline metals; this is worth notice in relation to possible reduction to nitrite and consequent loss of nitrogen in the combustion process. The view of Frankland that nitrites are producible in water by the reducing action of organic matter upon nitrates† is clearly sustained by the results for Nos. 64 and 65, these representing a water originally containing nitrates to which different amounts of an infusion of hay had been added; it seems by no means established that nitrites are *always* developed by reduction, some of Dr. Tanner's experiments which have been reported indicating that on the contrary these salts may be produced by oxidation, which, if it go on, leads to the formation of nitrates. Frankland's view, also, that nitrates are not found in waters deficient in dissolved oxygen, is in general accordance with the results obtained in this investigation, though there are a few instances—Nos. 20, 27, 43, and notably 33—in which nitrates are present to a considerable extent in waters with less than a full proportion of free oxygen in solution.

3. The experiments with tannin simply serve to show how uttterly worthless is this "group-reagent" of Kämmerer for the purpose for which he has advocated its use.

4. The general series of analyses of the dissolved gases comfirms what has been said on previous pages of the general report as to the number of varying conditions which influence the results in this direction—oxidizability of organic matter present, temperature, extent of exposure to the atmosphere, and interchange with it in both directions of gaseous constituents. In a number of cases the consumption of dissolved oxygen, and production in its place of carbon dioxide from the carbon of organic matter is very obvious, but the extent to which this is found going on varies greatly, and is masked by the escape to a greater or less extent of the latter gas and reabsorption from the air of the former. The conclusion of Weyl and Zeitler,‡ from a few experiments, that the quantity of free oxygen in solution does not bear any fixed ratio to the quantity of acidified permanganate decolorized by a water, is sustained by many of the specimens in the main series, as for instance, Nos. 60 to 80, inclusive. Nevertheless, it may be well to include an examination of the dissolved gases in the study of any water in regard to which the fullest chemical information is desired. In such a case the examination ought to be made with the least possible interval of time after collection of the sample, and preferably on the spot where the sample is taken, with observation of the temperature of water and air.

MICROSCOPICAL AND PATHOLOGICAL RESULTS.

Feeling my own incompetence properly to discuss these, I prefer to leave them to speak for themselves, except so far as Professor Martin

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*This appears to be the proper way of comparing the results of the permanganate with those of the combustion process. The former process is clearly concerned much more with carbon than nitrogen, if oxygen be usually at all consumed by nitrogen. It is not easy to admit the soundness of the logic with which Tidy (Jour. Chem. Soc. (Lond.), Jan., 1879, 94–97) points to the concordance of results, by the permanganate and combustion processes, and the disagreement with both these of the results by the albuminoid-ammonia process, and hence apparently infers that the two former are trustworthy, and the last not so. He uses the *sum of organic carbon and nitrogen* to represent the results by the combustion process, and as the carbon forms generally much the larger part of this, he naturally arrives at an agreement with the results of the process mainly depending on the oxidation of carbon, and disagreement with those of the process evolving nitrogen as ammonia.

†It is worthy of remark that the largest number of cases among natural waters of the Kubel process giving a lower result than that by the Tidy process occur among the waters believed to be *dangerous*, *i. e.*, Class II.

‡In accordance with the remarks of Frankland: "Water Analysis"; p. 55.

*It is true that Dr. Smart took no very special pains with these determinations, which were looked upon merely as incidental to the main object, checking to some extent the information as to the general character of each water. Still, this part of the work was done with fully average ordinary care.

†"Water Analysis," pp. 28 and 42.

‡Zeitschr. f. phys. Chem. 5; 10 (1880).

has, as quoted in a previous part of the general report, given his views as to the methods employed and the general significance of the facts recorded—these views having been formed, however, while he still was ignorant of the history of the individual waters.

It may be said, I think, that the microscopic and culture observations indicate at the same time the real importance of connecting with a chemical examination of water a study in competent hands of its microscopic organisms, both as to number and kind, and also the difficulty often presented, either by the sparseness or more frequently the abundance of these organisms, in fairly estimating their average relation to the mass of the water. This difficulty is superadded, of course, to the imperfection of our knowledge as to the effects upon human health of some closely allied—even hardly distinguishable—organisms, of dangerous and harmless associations, and of perhaps the same organism in different stages of its life history. The probable general significance of certain large classes of organized forms seems, however, well established, and well worthy of attention.

It may also be said of the pathological experiments with rabbits, that, opening up as they do a new and almost untried field of research, they show the great complexity of conditions to be encountered, the necessity of careful attention to details, and of multiplying and varying such experiments as far as possible, and the caution which must be exercised in drawing generalized conclusions from them; but on the other hand the results so far obtained, many of which individually are exceedingly suggestive, seem to indicate that real value attaches to this method of investigation, not in the direction proposed by Emmerich (as a part of the ordinary examination of a drinking-water, in order to determine directly its wholesomeness or the reverse), but as the means in part of arriving at trustworthy grounds for the interpretation of chemical and microscopical results.

SANITARY CONCLUSIONS AND INTERPRETATION OF RESULTS.

To admit of easier comparison the results by the chief processes examined have been thrown into graphical form in Tables XIX and XX, of which the former refers to the natural waters and the latter to those artificially prepared.

(These tables will appear with the general report.)

Chemical results contrasted with actual sanitary history of the natural waters examined.

1. An inspection of Table XIX shows that *no strongly marked generic difference is presented by the results from any of the processes for the estimation of organic matter or its elements between the generally wholesome waters of Class I and the medically condemned and fairly assumed as pernicious waters of Class II.* Judging by the general impression of the curves upon the eye, one would be inclined to attribute somewhat more importance to the results involving nitrogen than to those dependent upon carbon, but neither will afford the means of broadly distinguishing the two classes. This conclusion is otherwise illustrated by the figures in Table XXI.

TABLE XXI.—*Comparison of chemical results for waters of Classes I and II.*

	Least result.		Greatest result.		Average.	
	Class I.	Class II.	Class I.	Class II.	Class I.	Class II.
Organic carbon	.36	.33	7.20	7.79	2.36	2.08
Organic nitrogen	.08	.03	1.41	*6.88	.56	†.94
Sum of organic carbon and nitrogen	.44	.61	7.86	†8.31	2.92	†2.92
Nitrogen of free ammonia	.008	.008	.675	.295	.092	.090
Nitrogen of albuminoid ammonia	.016	.021	.268+	.214	.112	.099
Nitrogen of total ammonia	.028	.033	.704	.343	.204	189
Oxygen consumed in one hour (Tidy)	.062	.082	4.008	3.340	.995	.791
Oxygen consumed in three hours (Tidy)	.210	.104	5.212	4.188	1.305	1.065
Oxygen consumed (Kubel)	None.	None.	7.443	6.000	2.140	1.271

* This figure is undoubtedly too high, in consequence of incomplete reduction of nitrates. The next highest is 2.36, and even this is probably higher than the truth for the same reason.

† Including the no doubt erroneous highest single figure.

It will be seen from this table that no marked difference exists between the *highest*, *lowest*, or *average* result obtained by any of the processes for the waters of Class I and the corresponding result for those of Class II. No one could, with these figures to guide him, refer a water of unknown origin to one or the other of the two classes on the evidence afforded by chemical analysis, using any or all of the processes in question. The more varied results presented in Class III admit of being studied with some interest in connection with the history of the individual waters, but are not available for the main purpose of testing the chemical methods, as this class includes only waters the sanitary character of which in advance of examination was more or less doubtful—waters under suspicion only.

2. Making the most liberal allowance for the imperfection of the different processes for the estimation of organic matter or its constituents, it is well worthy of notice how very small is the absolute amount of organic matter indicated as present in many of the most dangerous waters, an amount so small as to furnish important evidence against any chemical theory of the production of disease from this source, any theory based on the simple assumption that some of the chemical products of the decomposition of organic matter are poisonous or noxious in their effect upon the human system. Thus, if *the whole* of the organic carbon and nitrogen found in such waters as Nos. 35 and 36, of the highly dangerous character of which there can scarcely be a doubt, existed as strychnine, it would be necessary to drink about half a gallon of the water at once in order to swallow an average *medicinal* dose of the alkaloid. It is not easy to believe that the ptomaines, or any other chemical products of putrefactive change as yet observed, can possess an intensity of toxic power so very much greater than that of the most energetic of recognized poisons. While numerous facts go to support the belief that, not to the effect of any chemical substances (such effect necessarily standing in definite relation to their quantity), but to the presence of living organisms with their power of practically unlimited self-multiplication, we must in all probability look for an explanation of, most at any rate, of the mischief attributable to drinking water, it is of course possible that indirectly a large amount of organic matter in water may be more dangerous than a smaller quantity, as furnishing on a greater scale the suitable material and conditions for the development of noxious as well as harmless organisms.*

Whether variations in the mere quantity of organic matter, within such limits as occur in water at all likely to be used for drinking, are of much importance in this respect, *i. e.*, as determinant of the presence or abundance of organisms, is a question which may be asked, and on it depends, I think, largely the utility of all attempts to determine or estimate the quantity of organic matter or its constituents as such.

3. A much more conspicuous difference between the waters of Classes I and II is presented by the results for nitrites and nitrates, as shown in Table XXII. (See last page.)

In this table a tenfold height is given to the ordinates representing the nitrites, the smaller quantity in which they occur requiring this exaggeration.

Here we find a very obvious connection between the results of chemical examination and the known sanitary character of the several waters, the salts of nitrous and nitric acid being either absent or present in but trifling amount in the waters of Class I, believed to be wholesome, almost universally present, and in many cases in large quantity, in the pernicious waters of Class II, and very variable as to presence and amount in the waters grouped together under the doubtful head of Class III. No aspect in which I have compared together the good and bad natural waters has afforded so definite a result as this.

This result is worthy of special attention in view of the different opinions which have been expressed as to the sanitary significance of nitrites and nitrates in water. Thus, Wanklyn says:† "The nitrates and nitrites have been erroneously regarded as measuring the defilement of water." "In fine, presence or abundance of nitrates does not show defilement by means of sewage, and deficiency of nitrates does not show absence of defilement. Many excellent waters have been condemned as unwholesome on account of the nitrates contained by them; and it cannot too strongly be insisted upon that the nitrates afford no data of any value in judging of the organic quality of a water." Angus Smith says:‡

"There are many interesting questions to be asked regarding nitrates. I am inclined to think that their presence shows that the most dangerous state of the organic matter is past. When they appear in any solution, the chief escape of putrid gas seems to have ceased; the water may, however, be still dangerous to use, and, of course, is revolting to the imagination." * * * §"Those nitrates, however, which do remain indicate that at least an equivalent of albuminous matter or sewage matter *did* exist."

Frankland clearly expresses his view‖ as to this evidence of "previous sewage contamination" thus:

"Large quantities [of nitrates] convict water of previous pollution by organic matters of animal origin. They tell only of the contamination which is past; but, by inference, they also declare the probable nature of the organic matter now present. * * * Whether or no the analyst should form an unfavorable opinion of the water from the amount of nitrates must depend upon the proportion of organic matter actually present, and on his confidence in the efficiency and uniform action of the purifying process."

As the basis of his determination of "previous sewage contamination" Frankland takes the sum of the nitrogen present as ammoniacal salts, nitrites, and nitrates, diminished by an allowance for the aver-

* Tiemann and Preusse have suggested that a polluted water may more *probably* contain disease ferments than a pure one, but it should not be inferred that an impure water is necessarily pernicious. Quoted in Chem. News, January 16, 1880, 30, 31.

† J. A. Wanklyn, "Water Analysis," Lond., 1879; 97, 98.

‡ Chemical News, September 3, 1869; 113.

§ Chemical News, June 25, 1869; 305.

‖ "Water Analysis for Sanitary Purposes"; 27.

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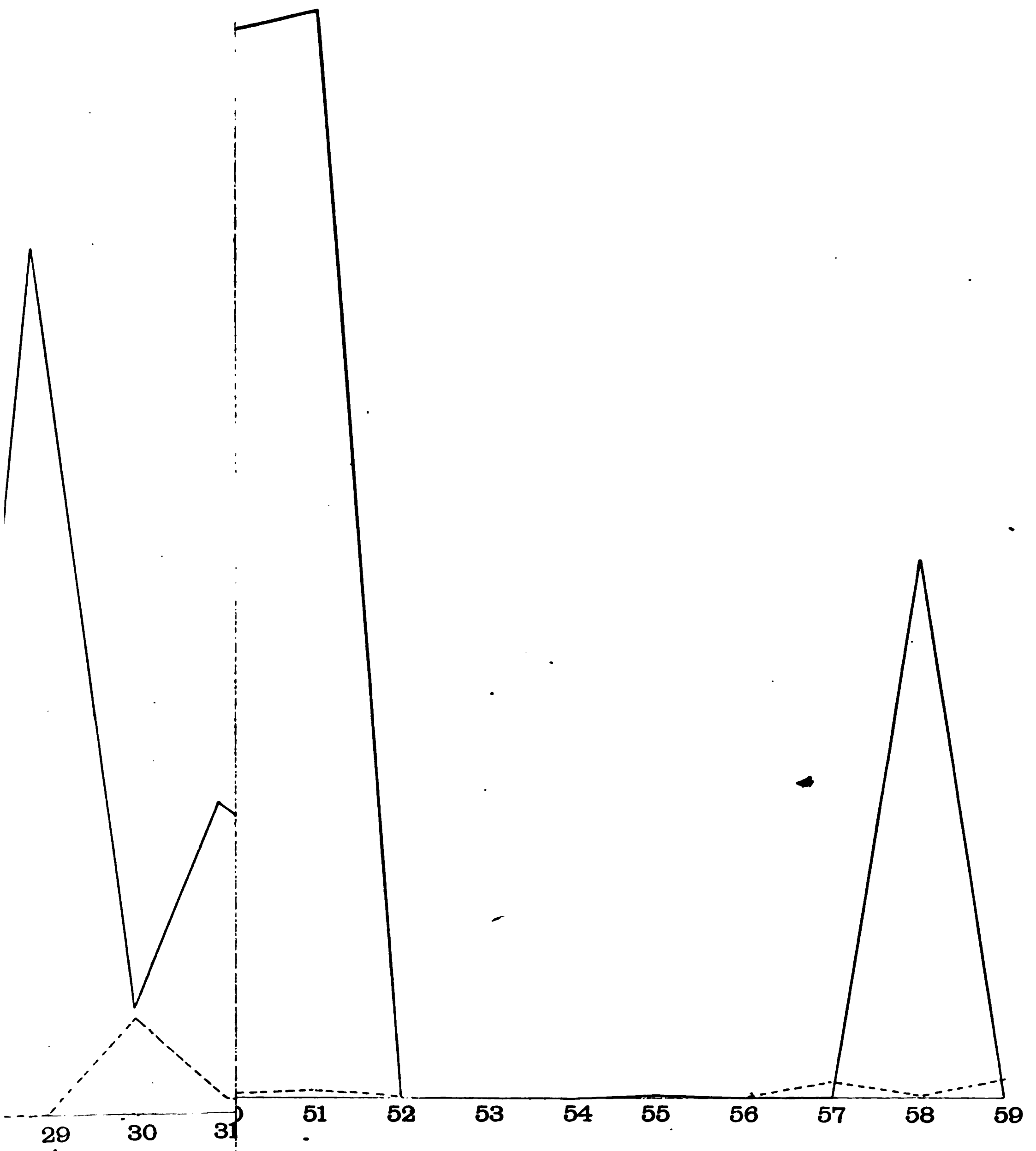

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TABLE XXI.—*Comparison of chemical*
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	Least result.	
	Class I.	Class II.
Organic carbon	.36	.33
Organic nitrogen	.08	.03
Sum of organic carbon and nitrogen	.44	.61
Nitrogen of free ammonia	.008	.008
Nitrogen of albuminoid ammonia	.016	.021
Nitrogen of total ammonia	.028	.033
Oxygen consumed in one hour (Tidy)	.062	.082
Oxygen consumed in three hours (Tidy)	.210	.104
Oxygen consumed (Kubel)	None.	None.

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age amounts of these substances in rain-water; he therefore treats the significance of the ammonia as the same with that of the nitrites and nitrates, as evidence merely of the past presence of nitrogenous organic matter, of which a part *may* remain.

Griess has expressed a strong opinion* as to the sanitary importance of detecting nitrates, and the unfitness of water for drinking purposes when containing them.

Ekin† attaches very great importance to the presence of nitrates and nitrites. Thus he says:

"Waters which have undoubtedly given rise to typhoid fever have been found by the writer over and over again not to contain more than 0.05 part of albuminoid ammonia in 1,000,000, and which, notwithstanding their containing a large excess of nitrates, have been passed by analysts of undoubted ability as being fit for drinking purposes. The attention of the writer was particularly drawn to this in the case of a district where typhoid fever was hardly ever absent, and where the conditions were such as pointed exclusively to water as being the aggravating cause. * * * Samples were taken when the pollution was evident, and analysed. Two only were found to contain an excess of albuminoid ammonia, but all contained a large excess of nitrates. * * * The significance of an excess of nitrates has already been sufficiently dwelt upon, and we have seen that both upon *a priori* grounds and as the result of actual experience, their presence in abnormal quantity is objectionable. * * * When the amount [of nitrates] exceeds 0.5 or 0.6 part [per 100,000], it points significantly to dangerous pollution; * * * nitrogen as nitrites should be invariably absent from a good water. * * * This view of the importance to be attached to an abnormal quantity of nitrates has been formed in spite of a considerable predisposition to a contrary opinion, and has been literally forced upon the writer again and again by the investigation of cases which really leave no doubt in the matter."

Reuben Haines, of Philadelphia, has furnished‡ the details of some cases in his own experience, which he says are "in partial corroboration of the opinions of Mr. Ekin."

Among the artificially polluted waters of the investigation now reported on, there are a number of samples of such general character as to attach to them the gravest suspicion on sanitary grounds, suspicion corroborated in sundry cases by the biological tests applied to them: in which, nevertheless, nitrates and nitrites are not found; but in these waters we find the quantity of organic matter extraordinarily large, and generally accompanied by very large amounts of ammonia—*e. g.*, Nos. 119, 120, 121 containing water in which the dead body of an animal had been allowed to macerate; Nos. 122, 123, 124 containing much blood from a slaughter-house, and Nos. 137 and 138 containing the dejecta from typhoid-fever patients.

Looking at the results from the natural waters of Classes I and II, and bearing in mind the conclusions reached by Müller, Schloesing and Müntz, Storer, Warington, and others§ as to the process of nitrification being due to the presence of an organized ferment or ferments of bacterial character, the idea suggests itself whether the noxious character of waters containing largely of nitrates and nitrites—themselves presumed to be harmless—, and but very little organic matter—which ought to be present, of some sort, to support the "previous contamination" view—*may not be in reality due to the presence of a special nitrifying ferment, itself to be classed among the lower organisms capable of propagating disease.*

4. Two points require to be borne in mind, suggestive of caution in drawing such conclusions as the above in regard to the sanitary in connection with the chemical character of water.

In the first place, the samples examined may possibly have undergone chemical change in the interval from their collection to their reaching the analysts, so that, for example, organic matter may have disappeared or nitrates may have been formed. With the precautions taken to lose as little time as possible, there does not seem much likelihood of such changes having occurred to so serious an extent as to essentially alter the character of the water.

In the second place, with the object which I had in view, of obtaining samples of water capable of producing disease, it was necessary to take what may be called *exaggerated instances* of mischief—well marked or comparatively violent cases of illness—since no others could well be traced with sufficient strength of probability to their supposed cause, and it may very possibly be that the organic impurities present in the waters concerned in such cases are not the same as those which would produce slighter, but in time serious, ill effects. Slighter forms of disease, in reality attributable to drinking-water, may perhaps be numerous, and possibly of various types, but generally the difficulty will be too great of securing, in view of the many factors concerned, any satisfactory evidence as to their cause. The collection of strongly-marked cases only, neglecting slighter ones if such exist, involves to some extent the same fault in principle as the commonly applied test of the death-rate for particular diseases in the discussion of local sanitary conditions; there may be numerous cases of illness, with but few deaths. The same difficulty also is experienced in trying pathological experiments on the lower animals; only strongly marked effects can be noted or satisfactorily connected with their supposed cause.

5. In regard to the comparatively rough determinations of chlorine, the results are, in many of the cases of water from shallow wells, significant enough of contamination by fluid animal excreta. The amounts of chlorine found in specimens Nos. 2, 3, and 4 of water from the deep artesian well at Charleston, S. C., and in No. 22 from a well near the sea on Staten Island, and Nos. 50 and 51 from a well, and No. 52 from a pond in the neighborhood of the sea at Newport, R. I., illustrate the need for thought as to the natural source of a water in drawing conclusions in connection with the presence of chlorides. Even in cases in which chlorine has come in with organic matter, the impropriety of too hastily deciding, as is sometimes done, that a small quantity indicates vegetable and a large amount animal contamination, is illustrated by the results for No. 65, containing an infusion of hay or dry herbage,* and for Nos. 87 and 88, containing the alkaline washings from wood pulp at a paper-mill, in contrast with those for Nos. 120 and 121, containing a very foul infusion of the body of a dead animal, and for Nos. 138 and 139, containing morbid animal matter from cases of typhoid and scarlet fever.

Biological results contrasted with the actual character of the waters examined.

The lists of waters marked (independently) by Professor Martin and Dr. Hartwell as "dangerous" and "suspicious" on the basis of the biological observations are summarized, in connection with the classes represented, in Table XXIII.

TABLE XXIII.—*Biological classification of waters.*

		Professor Martin.		Dr. Hartwell.	
Class.	No. in class.	Dangerous.	Suspicious.	Dangerous	Suspicious.
I	19	....	4	....	7
II	19	....	2	....	1
III	20	2	1	1	3
IV	20	3	3	3	2
V	21	4	5	2	10
VI	21	4	1	1	6
VII	15	4	3	4	7
VIII	4	1	2	2	1

1. It is evident on inspection of this table for Classes I to III, that, as has been remarked on a previous page, the biological methods employed will not afford the means of deciding between a wholesome and an unwholesome natural water. Several of the waters believed to be fairly wholesome for human consumption, certainly in use for drinking purposes on a large scale, are marked "suspicious," while not one of the waters believed to have proved themselves pernicious when used by man are set down as "dangerous."

2. In many cases the waters which produced most decided effects upon the rabbits contained *very large* amounts of organic matter, so large as to probably invalidate a comparison with the natural waters or with much more dilute specimens of artificial preparation.

3. On the other hand, we find in several instances, on comparing the pathological results from three different strengths of a solution of the same organic material, that it is not the strongest which has produced the most marked effects.

4. In probable support of the idea that it is not mainly the quantity of organic matter, but the presence and nature of low organisms which render drinking-water unwholesome, such cases deserve attention as No. 83 in contrast with Nos. 84 and 85, and also Nos. 131, 132, and 133 (if the deaths of comparison rabbits be not considered to vitiate the results) in contrast with Nos. 134, 135, and 136. Here the pernicious character of waters containing relatively but very little organic matter seems to be distinctly indicated.

5. It is pretty plain that much difficulty in the interpretation of the biological results arises from too great differences of absolute strength in the solutions of organic matter used. In any future attempt to extend investigation in this direction it would be well to more nearly equalize the dilution, though it might perhaps prove necessary to use in all cases more organic matter than is usually found in potable water of natural origin.

Chemical results as to animal in contrast with vegetable organic matter in water.

1. In general the conclusions are sustained which have been usually drawn in regard to the source of organic matter, based on the more highly nitrogenous character of that from animal than that from vegetable *debris*. This remark applies to the ratio of organic C : N obtained by the combustion process (although the value of the figures is much reduced by the errors in the method which have been

*Ann. d. Chem. u. Pharm., CLIV; 336.

†"Potable Water," 2d ed., Lond., 1880; pp. 15, 16, 22, 25, 26, 27, 28, &c.

‡"Methods for judging of the wholesomeness of drinking-water." From Journal of the Franklin Institute, February, 1881.

§Comptes rendus: 84, 301; 85, 22, 1018. Jour. Chem. Soc. (Lond.), January, 1878, 44; July, 1879, 429. Chem. News, November 4, 1881, 217, &c.

*It is possible that salt may have been sprinkled over this hay in curing it, as is sometimes done, though I have no special reason to suppose so. It was upland, not salt-marsh, hay.

pointed out), and also to the amounts of albuminoid ammonia obtained, and the consumption of oxygen from acid permanganate.

2. But the necessity for caution in drawing such conclusions, or the propriety of substituting for the statement that a given water is polluted by, say, animal matter, rather the simple assertion that the polluting material is of highly nitrogenous character, is illustrated by such cases as Nos. 89, 90, and 91, containing the alkaline washings from the manufacture of starch, and Nos. 98, 99, and 100, containing the refuse from canning tomatoes. These waters might well be supposed to be contaminated with animal matter from the evidence afforded by the chemical results, interpreted in the usual way.

3. On the other hand, the results for Nos. 104, 105, and 106, containing a watery infusion of human fæces, especially the C:N ratio, might be taken to indicate the presence of vegetable matter. This fact, well deserving attention from a sanitary point of view, is opposed to the evidence of pollution obtained where urine alone is concerned, and might modify the conclusions drawn in cases involving drainage from mixed solid and fluid excreta. The fact itself is intelligible in view of the tendency to accumulation and ultimate rejection from the intestines of the vegetable fiber* of our food and the products of its limited alteration, as well as the highly carbonaceous character of the biliary discharges.

4. The different rate of removal from water of organic carbon and organic nitrogen is in one form illustrated by the comparison of No. 119 with No. 120 and No. 121, all three containing the watery liquid in which the body of a dead animal had been macerated, as also No. 128 in contrast with Nos. 129 and 130, all containing washings from wool. The true effect of the changes taking place in the water is, however, blended with and partially obscured by the effect of difference of strength on the errors which have been pointed out belonging to determinations by the combustion process. The bearing of such changes in the C:N ratio, from both causes, on the conclusions to be drawn as to the source of pollution is very obvious.

5. Dr. Smart, in interpreting his results by the albuminoid-ammonia process, aided, however, in some cases, by his application of the Kubel form of the permanganate process, has for most of the waters in which the organic matter was of known character (though unknown at the time to *him*) attempted to distinguish between that of vegetable and that of animal origin, and his conclusions are given in column 45 of Table X. On examining these it will be seen that in a very large proportion of cases he has been right, while some of those in which his deductions are incorrect are intelligible in the light of full consideration of all the facts. Thus, he has referred Nos. 105 and 106, containing infusion of human fæces, to the class of vegetable matter, this case having been alluded to above; and Nos. 108 and 109, containing drainings from a pile of stable manure, to the same class, this being in many respects an analogous case, and, indeed, a more strongly marked one of its kind.

Biological results as to animal in contrast with vegetable organic matter in water.

1. Decidedly the most noteworthy result under this head is the well-marked pathological effect produced upon rabbits by the injection of waters contaminated solely by such vegetable matter as would usually be esteemed harmless. An account has been given on previous pages of the general report of the repeated experiments with water containing an infusion of dead forest leaves (No. 68), all leading to essentially the same result. A like effect followed from the experiments with the peaty waters of the Dismal Swamp (Nos. 78 and 79).

While there have hitherto been occasional allusions by sanitary writers† to slight indisposition now and then experienced by persons drinking the peat water of mountain streams, it has been usually assumed that peaty water is *not* unwholesome, strong language on this head being often used,‡ and that, in general, organic matter of vegetable origin is harmless, or comparatively harmless, while that of animal origin is highly dangerous.§ The results above referred to indicate that, under the special conditions of the experiments with rabbits, vegetable matter representing mainly or largely alteration products of woody fiber may be in a high degree pernicious.

2. It will be seen that for nearly all the waters classed as "dangerous" by Professor Martin and Dr. Hartwell the ratio of organic C:N was rather high.

3. The above conclusion as to the apparent possibility of vegetable organic matter proving itself decidedly injurious has to be qualified by observing that in the well-marked cases of such results the amount of organic matter present in the water was large, and it would not be safe to affirm on this evidence alone that similar waters, if diluted to the ordinary potable standard,‖ would still prove themselves capable of causing disease or death in the animals experimented on; indeed, the evidence tends rather the other way, so far as the experiments go which were made by injecting the rabbits with *the same quantities* of weaker solutions. But, on the other hand, water containing as much vegetable organic matter as No. 78 is often used for drinking purposes in peaty districts, and this very Dismal Swamp water has often been taken by choice as the supply for ships leaving port, and has been spoken of as a source of supply for the city of Norfolk; so that the discussion of wholesomeness or unwholesomeness of such water is not without practical interest.

* The infusion used was strained, but not filtered. It contained a good deal of very fine suspended material.

† Angus Smith, in Chem. News. June 25, 1869; 304. Ekin, "Potable Water," p. 15; foot-note. 6th Report of Pollution of Rivers Commission, p. 34.

‡ Tidy, Jour. Chem. Soc. (Lond.), Jan., 1879; 65. Ekin, "Potable Water," p. 15.

§ Frankland, "Water Analysis," 93–97. Tidy, Jour. Chem. Soc. (Lond.), Jan., 1879, 80–83. Ekin, "Potable Water," pp. 12, 13, 14, 15, &c. R. Haines, Methods for judging of wholesomeness of drinking waters, p. 11. De Chaumont, Arch. Ch. Pharm., XVII, 124.

‖ See 6th Report of Pollution of Rivers Commission, p. 34.

4. If the theory be accepted, which has so much in its favor, attributing the production of disease by organic matter in drinking-water not to any specifically poisonous *substance* or substances, but to the presence and action of living organisms, it seems quite conceivable that a water containing organic matter of any kind, including vegetable matter, may be harmless at one time, and harmful at another, when perhaps a different stage of fermentation or putrefactive change may have been entered upon, and special organisms may have made their appearance or entered upon a new phase of existence. Thus there might possibly be safety in drinking a peaty water, or water filtered through beds of dead forest leaves, when fresh, danger when after a certain amount of atmospheric exposure bacterial organisms had become developed, and safety again, perhaps, after the growth of such organisms had fallen off and more or less of the available organic matter had been consumed. I have been informed that old ship-captains who have often carried the water of the Dismal Swamp to sea entertain a belief that this water undergoes a "kind of fermentation," after which it becomes remarkably good and wholesome. In support of some such idea as to different stages passed through by a water (containing vegetable matter) as to the development of organisms and sanitary character, leading to the possibility, on its being stored, of wholesomeness at one time and unwholesomeness at another, the microscopical and biological reports of Nos. 62, and 69, 70, and 71, are worthy of notice.

Evidence afforded by chemical results as to putrescent or non-putrescent character of organic matter in water.

1. Tidy has claimed* as one of the merits of the permanganate process, that it enables the distinction to be drawn between "putrescent and easily oxidizable" and "non-putrescent or less easily oxidizable" organic matter, and has given the results of some experiments to show that the former are, for the most part at any rate, disposed of within the first hour; hence his rule as to determining separately the consumption of oxygen in that time and in three hours, and comparing the results, by means of which comparison he says "we obtain data of great value by which to judge the nature of the organic impurity." In column 28 of Table X, I have given the ratio of the consumption of oxygen from permanganate used as directed by Tidy in 1 hour to that in 3 hours, the latter quantity assumed = 100. The results for those waters, the nature of the organic matter in which was known, are obviously affected variously by sundry conditions, such as the different strengths of solutions, the presence together of both easily and less easily oxidizable matter, &c., but on the whole do not afford much support to the opinion expressed by Tidy. He distinctly assumes animal matter to be, at any rate as a rule, more "putrescent and easily oxidizable" than vegetable matter, but on examining the percentages in column 28, taking the averages for the different classes of waters, we find—

	Per cent
Organic matter of vegetable origin:	
For Class IV	84.0
For Class V	80.8
Organic matter of animal origin:	
For Class VI	74.5
For Class VII	77.6
For Class VIII	79.0

Thus, although the differences are not very great, the proportionate consumption of oxygen within the first hour is rather greater for those waters containing vegetable than for those containing animal matter. Again, judging merely by appearance, smell, &c., I should say that the waters in the foulest and most actively putrescent condition were those containing the alkaline washings from a starch factory (Nos. 89, 90, 91), the washings from the bag-filters of a sugar refinery (Nos. 92, 93, 94), the refuse from canning tomatoes (Nos. 98, 99, 100), infusion of human fœcal matter (Nos. 104, 105, 106), infusion of the body of a dead animal (Nos. 119, 120, 121), mixed drainings from a slaughter-house (Nos. 125, 126, 127), and the dejecta from typhoid fever patients (Nos. 137, 138); the average consumption of oxygen for all of these in one hour is 80 per cent. of that in three hours; almost exactly the same wi h the mean of all the above figures for the five classes examined (giving them equal value), viz, 79.2 per cent.

2. On the other hand, Dr. Smart has expressed the opinion, based upon his previous extensive experience with the albuminoid-ammonia process, aside from his work with it in connection with the present investigation, that *gradual* evolution of albuminoid ammonia indicates the presence of organic matter, whether of vegetable or

* Jour. Chem. Soc. (Lond.) Jan., 1879; 78, 80, 97.

animal origin, in a fresh, or comparatively fresh, condition, while *rapid* evolution indicates that the organic matter is in a putrescent or decomposing condition. In column 45 of Table X will be found his application of this principle of interpretation to his results obtained from the waters examined; the detailed facts as to the rate of evolution of albuminoid ammonia in the measures of distillate successively collected will be found in Appendix D. It will be seen that in a very large proportion of the cases before him Dr. Smart has interpreted correctly the general character of the water as to putrescence or comparative freshness of condition of the organic matter. Examples, however, of erroneous results from this principle of interpretation are furnished by Nos. 77, 92, 93, 94, 125, 128, and 131, nearly all of which, it may be observed, were very dilute liquids, and perhaps by the waters (Nos. 113, 114, 116, 117, and 118) containing mixed sewage from Richmond and Washington, though these, also quite dilute, can hardly be quoted as examples involving a known degree of putrescence on the part of the organic matter.

Biological results in connection with putrescent or non-putrescent character of organic matter in water.

On the whole the biological results obtained, taken in connection with the history and condition of the water samples in which the nature of the organic matter was known, are in accordance with the general belief that putrescent organic matter is more dangerous than that in a fresh or but slowly decomposing condition. Taking the twenty waters which have been noticed above, as containing the most obviously foul, evil smelling, and actively putrescent material, in some of vegetable, in others of animal origin, and comparing these with the lists of waters, as classified by Professor Martin and Dr. Hartwell, we find nine classed as "dangerous," and seven as "suspicious"; of the remaing four, the fact that two represented the weakest dilutions of materials, which in stronger solutions produced marked pathological effects, deserves to be noticed.

GENERAL CONCLUSIONS, WITH A VIEW TO SANITARY APPLICATION, AS TO THE VALUE, SEPARATELY AND COLLECTIVELY, OF THE DIFFERENT PROCESSES OF WATER ANALYSIS WHICH HAVE BEEN UNDER EXAMINATION.

1. It is not possible to decide absolutely upon the wholesomeness or unwholesomeness of a drinking water by the mere use of any of the processes examined for the estimation of *organic matter*, or its constituents.

2. I would even go further, and say that, in judging the sanitary character of a water, not only must such processes be used in connection with the investigation of other evidence of a more general sort, as to the source and history of the water, but should even be deemed of secondary importance in weighing the reasons for accepting or rejecting a water not manifestly unfit for drinking on other grounds.*

3. There are no sound grounds on which to establish such general "standards of purity," as have been proposed, looking to exact amounts of organic carbon or nitrogen, "albuminoid ammonia," oxygen of permanganate consumed, &c., as permissible or not. Distinctions drawn by the application of such standards are arbitrary, and may be misleading.

4. Two entirely legitimate directions seem to be open for the useful examination by chemical means of the organic constituents of drinking water, namely, first, the detection of *very gross* pollution, such as the contamination of the water of a well by accidental bursting or crushing of soil-pipes, extensive leakage of drainst, &c., and secondly, the periodical examination of a water supply, as of a great city, in order that, the normal or usual character of the water having been previously ascertained, any suspicious changes which from time to time may occur shall be promptly detected and their cause investigated.

5. In connection with this latter application of water analysis, there seems to be no objection to the establishment of *local* "standards of purity" for drinking water, based on sufficiently thorough examination of the water supply in its usual condition.

6. With the facts of this investigation before me, I am inclined to attach special and very great importance to a careful determination of the nitrites and nitrates in water to be used for drinking.

7. If I had intrusted to me the charge of watching a large city water supply I should use all three of the principal processes for the examination of the organic matter present; each gives a certain amount of information which the others do not afford.

Under circumstances admitting only of the use of simpler means of investigation, the albuminoid ammonia and permanganate processes might be employed together, but in no case should one only of these methods be resorted to, such a course entailing practically the neglect of carbon on the one hand or nitrogen on the other.

PRACTICAL SUGGESTIONS, DRAWN FROM THE EXPERIENCE OF THE INVESTIGATION NOW REPORTED ON, AS TO THE USE IN THEIR PRESENT FORM OF THE CHEMICAL PROCESSES STUDIED.

Examination of water samples in general.

1. Great care should be taken that water samples be placed in the hands of the analyst and their examination begun with the least possible delay after they have been collected. The changes which take place, sometimes rapidly, on keeping, may seriously affect the results, especially in the case of waters much polluted by foul organic matter.

2. It is very desirable that, besides examining a water in its perfectly fresh condition, samples of it should be set aside, in half-filled but closed glass-stoppered bottles, for some time—say 10 or 12 days—and one of these examined every day or two, so as to trace the character and extent of the changes undergone. Not only may conclusions be drawn from such a series of observations as to the general stability or decomposibility of the organic matter present, but light will be thrown upon the changes which may be expected to occur under ordinary conditions when the water is stored for use, as in cisterns, wells during periods of drought, or carelessly allowed to remain stagnant in pitchers, water-coolers, &c.

Combustion process.

1. In applying this process, no matter how skillful or well trained the analyst may be, duplicate or even triplicate concordant results should be insisted upon before accepting the determinations as trustworthy.

2. In order to avoid the presence in the atmosphere, about the water-bath used for the evaporation, of ammonia derived from coal-gas, the bath should be heated by steam brought in a small, closed pipe from a distant boiler, preferably situated in another room, and the waste steam and condensed water therefrom should be in like manner carried off to a safe distance.

Albuminoid-ammonia process.

1. In order to avoid the uncertain ending of the collection of ammonia, whether "free" or "albuminoid," it would be well to adopt the rule that the distillation be stopped when, and not before, the last measure of distillate collected contains less than a *certain proportion*—say 1 per cent.—of the whole quantity of ammonia already collected. This would in many cases involve the necessity of replenishing the liquid contents of the retort with ammonia-free water.

2. In order to diminish the loss of amines or other volatile forms of nitrogenous matter, a separate distillation should be made with alkaline permanganate added *at once*, in addition to the usual course of treatment prescribed by Wanklyn—distillation begun with sodium carbonate, and continued after addition of the alkaline permanganate. The results of the two separate distillations should then be compared.

3. In reporting the results obtained by the albuminoid-ammonia process, including the determination of free ammonia, the details of the evolution of ammonia, as collected by separate measures of distillate, should always be given.

Permanganate process.

1. In view of the evidence obtained rendering probable the loss of organic matter by volatilization in the use of acidified permanganate at a boiling temperature, the Tidy form of the process is rather to be recommended than that of Kubel if but one be used.

2. On the other hand, the advantage of more extended oxidizing action, and the greater *general* accordance of the results by the Kubel process with those for organic carbon by the combustion process, make it desirable that as far as possible the same advantages should be secured by substituting the influence of time for that of temperature, and that the time during which the permanganate is allowed to act in the Tidy process should be increased to at least 12, better to 24, hours, *several* determinations (on different samples set aside at the same time) being made at such intermediate intervals as 1, 3, 6, 9, and 12 hours, in order to trace the progress of the oxidation.

SUGGESTIONS AS TO POSSIBLE IMPROVEMENTS ON THE PROCESSES EXAMINED DESERVING FURTHER INVESTIGATION.

Combustion process.

1. I would propose to evaporate the water, not under ordinary pressure and in contact with the atmosphere, as usual, but as the

* It will not do merely to throw all doubts on the side of the rejection of a water, as has been more or less advocated by writers on water analysis, for there are often interests of too serious character involved in such rejection to admit of its being decided on, save upon really convincing evidence of its necessity. In view of the great and increasing difficulty of securing an adequate supply of water of satisfactory character for very large cities, is it an unpractical fancy that there may yet come to be provided a double supply through separate pipes; 1st, of water for drinking and cooking purposes only; and 2d, of water less carefully selected as to source and storage for bathing, washing, house and street cleaning, extinguishing fires, &c., the former at any rate dispensed through meters to regulate consumption?

† Dr. J. S. Billings, U. S. A., of the National Board of Health, has suggested to me in conversation a useful subject of inquiry, viz. the possibility of tracing up the passage of polluting material through a soil by leaching samples of the soil itself, taken at various distances from the source of pollution, or from the water likely to be affected, and chemically examining the liquids obtained.

specimens of water were evaporated for the biological experiments, in a closed vessel immersed in a water-bath and connected with a good (water jet) air pump, so as to secure a nearly complete removal of air, with a condensing worm to dispose in part of the aqueous vapor given off. It would not do to simply place the water in a flask, since the residue could not be removed for combustion, but it would not be difficult to arrange a suitable vacuum vessel, with wide mouth and tightly clamped on cover, within which might be placed the usual glass dish to receive the water, and the feed might be managed through a nearly capillary tube with a glass stop-cock. By such an arrangement the evaporation might be effected within a moderate time at a fixed temperature much lower than the boiling point, thus probably reducing any loss from simple volatilization of organic matter; the nearly complete exclusion of air would tend to greatly diminish or do away with loss of organic matter by oxidation, and permit of large reduction in the quantity of sulphurous acid used; for the same reason the tendency to formation of sulphuric acid would be reduced to a minimum, and the absorption of ammonia from the atmosphere about the dish would be altogether prevented. In testing this last-named effect, two bulb-tubes containing pure sulphuric acid might be interposed between the vacuum chamber and the pump; the contents of the one to be tested for ammonia given off from the water, those of the other to guard against any trace of ammonia coming back from the outside air during irregular action of the stream of water.

2. In order to avoid loss during the evaporation of readily volatile substances, such as butyric, valerianic, &c., acids, to dispense with the necessity for the uncertain and unsatisfactory correction for ammonia lost by dissociation, to get rid of the influence on the determination of organic nitrogen of any errors in the determination of the total ammonia, and to avoid corresponding difficulties arising from the presence of nitrates if these be allowed to remain, it might be well to evaporate at first with the addition of a small excess of magnesia (as recommended by Lechartier), thus removing all ammonia, and then, the water having been brought down to a small volume, add a moderate excess only of sulphurous acid* with a drop of a solution of a ferrous salt (as directed by Frankland), and complete the evaporation to dryness—the whole process to be carried out in a jet-pump vacuum, as above suggested.

3. Further experiments are desirable in order to completely determine the merits and defects of the Williams ("copper-zinc couple") method for the removal of nitrates.

4. Some preliminary experiments of my own have seemed to show that nitrates and nitrites may be completely reduced by evaporating to a small bulk with no great excess of phosphorous or hypo-phosphorous acid, guarding against the evolution of phosphuretted hydrogen by the low temperature employed, then adding magnesia in small excess and completing the evaporation, thus leaving the residue in a pulverulent instead of sticky condition, easy of removal from the dish, and probably allowing of complete combustion without inconvenience from the final oxidation of the small excess of phosphite or hypophosphite, and without any wrapping up of carbon particles. This plan deserves to be carefully tested.

Albuminoid-ammonia process, including determination of free ammonia.

1. In order to prevent, or at least to largely reduce and render uniform, the loss of ammonia from imperfect condensation, I would prefer to effect the distillation, not by a lamp-flame, but in a retort of uniformly determined shape and size, uniformly immersed in a bath of saline solution or other suitable material kept at a uniform temperature—say 102° or 105° C.—by means of steam, and to condense in a glass worm, surrounded by ice-water, sufficiently long to bring the distillate to a uniform temperature, not exceeding, say 5° C.

2. It would be perhaps still better to conduct the distillation in a completely closed apparatus, with a fixed difference of temperature between the retort and the far end of the fully effective condensing tube, with a glass stop-cock to draw off the distillate in successive measured portions, and a little safety-valve (mercury or other) near the cold end to prevent any dangerous difference of external and internal pressure.

3. In the determination of *free* ammonia, with a view to distinguishing as sharply as possible between ammonia really existing as such or in ammoniacal salts and that found by breaking up of organic matter, it might be well to try a closed distilling apparatus connected with a (water-jet) air-pump, so as to maintain a partial vacuum within, keeping the retort at a fixed temperature much below 100° C. and collecting the whole of the ammonia in a flask and one or more bulb tubes containing rather weak mineral acid, interposed between the condenser and the pump. This would, however, be attended with the disadvantage of not readily permitting the progress of the evolution of ammonia to be traced by its collection in separate successive measures of distillate; and it would become necessary to ascertain whether the application of the Nessler test would be in any way interfered with by the sodium salts formed from the acid used to collect the ammonia.

4. In order to overcome, if possible, the most serious difficulty in the way of a correct determination of free ammonia, namely, the ready breaking up of urea (and other amides), when present, on heating with sodium carbonate, it would be well to ascertain at how low a temperature and within what time, if at all, ammonia really existing in ammoniacal salts could be completely driven off from an *extremely dilute* solution by adding a small excess of magnesia and maintaining a (water-jet) air-pump vacuum above the liquid, forming a stratum of small depth, with bulb tubes of acid between the liquid and the pump to intercept the ammonia, and guard tubes to prevent any being received from the air; in other words, to ascertain whether Schlœsing's method for the determination of ammonia admits of being applied to such excessively minute amounts of it as the water analyst is concerned with.

5. In the conduct of the albuminoid-ammonia process proper, *i. e.*, the distillation with alkaline permanganate, I would propose that the original volume of liquid in the retort be maintained *constant*, by running in at the proper rate, through a nearly capillary tube with a glass stop-cock, ammonia-free distilled water. And, in cases in which the amount of organic matter is so large as to wholly, or in great part, reduce the usual charge of alkaline permanganate, I would determine by a preliminary experiment at about what rate the reagent is used up, and would then progressively supply its solution, instead of simply pure water, at such a rate as to keep the original strength as nearly as possible unaltered.

Permanganate process.

1. The principle involved in the last paragraph applies also to this process. Instead of using a fixed amount of permanganate at first, and adding a second or third charge only when the former has been completely reduced, there ought to be a fixed excess at the end of the action, or rather there should be present a constant excess all through the process. Hence, when a preliminary experiment has shown that more than the usual charge of permanganate will be needed, and about the rate at which it will be consumed, for the final experiment additional permanganate solution should be gradually dripped in, from a nearly capillary tube, at such a rate as to maintain the original excess as nearly as possible constant.

2. It is desirable that the process be carried on at a pretty nearly fixed temperature.* If the Tidy method be followed, a temperature of say 20° C., could, with a little management, generally be secured, and the flasks kept approximately at this point during the time required for the action.

SUGGESTIONS AS TO FURTHER INVESTIGATIONS IN GENERAL CONNECTION WITH THE SUBJECT-MATTER OF THIS REPORT.

1. It is much to be wished that more extended biological experiments should be made upon the effects of water variously polluted on the lower animals, and that in such experiments the action of water introduced into the stomach as well as hypodermically injected should be tested, and other animals (such as dogs) used as well as rabbits.

2. It would be well to have chemical examinations, on a strictly uniform plan, from time to time made of the water supply in a few of the largest cities at periods when, not mortuary statistics, but the general assent of well-informed members of the medical profession, ascertained through local sanitary authorities, indicates unusual prevalence of, or unusual exemption from, the classes of disease most probably capable of origination from the organic pollution of drinking water.

3. I would *especially* suggest a combined chemical and biological inquiry as to the possible effects upon living animals of the ferment or ferments of nitrification in different stages of that process. In connection with this some minor questions connected with the development of nitrites and nitrates from decomposing organic matter are pointed to, by facts observed in the course of the investigation now reported on, as deserving further examination.

CONCLUSION.—ACKNOWLEDGMENT OF ASSISTANCE RECEIVED.

It remains only for me to record my thanks to the following gentlemen for aid of various kinds, obligingly rendered, in connection with the work which forms the subject of this report:

To Prof. H. Newell Martin, of the Johns Hopkins University, for his kind consent to take charge of the biological part of the investigation.

To Dr. Chas. Smart, U. S. A., Dr. J. A. Tanner, U. S. N., and Mr. W. A. Noyes, Graduate Scholar of the Johns Hopkins University, for the zeal, care, and patience with which they carried out the actual chemical examination of the waters.

To Dr. E. M. Hartwell, Fellow of the Johns Hopkins University, for like valuable aid in the conduct of the biological work.

To Prof. Ira Remsen, President D. C. Gilman, and the trustees of the Johns Hopkins University, for facilities kindly afforded for the portion of the work carried out in the laboratories of that institution.

*I doubt, however, the possibility of fully reducing nitrates, by means of sulphurous acid, if they are present in large quantity.

*For experiments on the varying extent of action of permanganate upon organic matter in water at different temperatures, see Bericht. d. deutsch. chem. Gesellsch., 14; 1015.

National Board of Health

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NOTICE.

The appropriation for printing being exhausted, pending legislation the further issue of the BULLETIN will be suspended.

QUARANTINE REGULATIONS AT APALACHICOLA, FLA.

PROCLAMATION OF THE BOARD OF HEALTH.

SECTION 1. The jurisdiction of the board of health shall extend to the boundary lines of the county.

SEC. 2. All vessels arriving at the port of Apalachicola, on and after June 1, 1882, whether foreign or domestic, and especially those from infected ports in which yellow fever is prevailing or from ports where other infectious or contagious diseases are reported to exist, are required to report at the quarantine station to be hereinafter designated, and be inspected and submit to a cleansing and disinfecting process, by the quarantine physician or inspector.

The station for vessels entering East Pass shall be at Pilot Cove, on the west side of East Pass, at or near Saint George's Island.

The station for vessels entering West Pass shall be at the buoy at Higgins Flat.

SEC. 3. All vessels arriving from an infected or suspicious port will be held in quarantine not less than 30 days from date of departure from said port, and shall be cleansed and fumigated as the port physician may direct, and said vessel shall undergo a second disinfection and fumigation, if deemed necessary by the port physician, except when such vessel may have undergone an examination and disinfection at Ship Island and furnishes satisfactory proof of same.

SEC. 4. Vessels arriving from ports named in section 2, requiring more than thirty days to complete voyage, will be held in quarantine ten days or longer if deemed necessary by the quarantine physician.

SEC. 5. Any vessel having on board any person ill with any infectious or contagious disease, on approaching the harbor of Apalachicola, shall be notified by the pilot that said vessel proceed at once to Ship Island, a refuge station for special sanitary care under the directions given the officers of the station by the National Board of Health, and it shall be the duty of all pilots, before boarding any vessel, to ascertain if such vessel is from any such port, as named in section three, and shall not board such vessel; but the vessel may follow the pilot to the quarantine station and there remain for inspection and fumigation. Should any pilot or other person board such vessel, he or they shall each be fined in a sum not exceeding $250. And no vessel shall be permitted to take any cargo while performing quarantine.

SEC. 6. No vessel arriving in the harbor of Apalachicola on and after June 1, 1882, during the existence of quarantine operations for the year, shall, under any circumstances, land any person, boat, or goods, anywhere within the harbor of Apalachicola, or approach the city of Apalachicola, nor permit any person or persons not legally authorized, to visit or communicate in any way whatever until she shall have been fumigated and performed quarantine, in accordance with the regulations of this board of health; and if any master or person in charge of any vessel shall give false information to any pilot, inspector, or port physician relative to condition of crew, passengers, cargo, or ballast, or of the health of the ports from whence she came, or refuse to give such information as shall be lawfully required, he shall be fined not exceeding $100.

SEC. 7. The quarantine physician shall be at all times, between sunirse and sunset, ready to visit and board all vessels as soon as apprised of their arrival in the bay, at the point hereafter designated by a flagstaff showing a yellow flag. He shall show a yellow flag conspicuously in his boat to designate his character; and if any vessel or boat shall, under any circumstances, pass by the quarantine boat or flag station, or refuse to obey the orders of the quarantine physician or inspector, the master or owner of any vessel or boat so offending shall be held to answer in a fine not exceeding $500, and may or shall be imprisoned until such fine and costs be paid.

SEC. 8. It shall be the duty of pilots or other persons bringing vessels into the bay of Apalachicola to hoist a flag half-mast at the fore, and not to pass the quarantine flag until the vessel has been visited by the quarantine physician; and it shall not be lawful for any person to visit or communicate with any vessel being taken into quarantine, or in quarantine, until said vessel has been visited by the quarantine physician and relieved from quarantine. Any person guilty of violating the provisions of this section shall be fined in a sum not exceeding $300, and any master of any vessel permitting any such communication shall also be fined in a sum not exceeding $300.

SEC. 9. No pilot or other person, except an inspector, shall leave any vessel after coming into Apalachicola Bay (or Saint George's Sound), without a written permit to do so from the quarantine physician. It shall be the duty of the quarantine physician to cause any vessel having any sickness on board to be anchored at least three-fourths of a mile from other vessels, which have no sickness on board, and it shall be his duty to prohibit any intercourse whatever between such vessels. Should any such intercourse take place, it is his duty, as well as the duty of the inspectors, to promptly report it to the president of the board of health; and any master of any vessel so offending shall be fined in a sum not exceeding $300.

SEC. 10. The quarantine physician shall charge the visiting fee of $5 in all cases where he attends patients on board vessels, and charge for all medicines and supplies furnished to the respective vessels. Such fees and charges to be collected from the master or owners of vessels to which such patients belong, and such fees and charges to be paid over to the secretary of the board of health.

The quarantine physician shall have full and complete control of the quarantine stations and the employés therewith connected, subject to the orders of the board of health, and in all cases in which he deems it necessary shall require vessels in quarantine to discharge their ballast or cargo under his orders and direction and undergo such fumigation and cleansing as required by these regulations as he may deem necessary; but all ballast of earth, sand, or porous stone, shall be deposited under water at a point to be designated by the port inspector or physician.

SEC. 11. The quarantine physicians shall examine into the condition of every vessel going into quarantine and the health of persons on board, and shall not permit any vessel or boat or person from any vessel to approach the city until the requirements of the regulations have been fulfilled; and, further, until he is satisfied that the public health will not be endangered thereby.

SEC. 12. All vessels at quarantine shall keep a flag at half-mast at the fore during the day and a lantern in the same position at night, and any master or person in charge violating this section shall be fined in a sum not exceeding $100, which shall be paid by the master or owner of such vessel.

SEC. 13. Any person visiting or attempting to visit any stations, while any vessel may be there which has not been released from quarantine, without permission from the quarantine physician, shall be fined in a sum not to exceed $300.

SEC. 14. Vessels at quarantine requiring water, fresh provisions, or stores, shall communicate with the quarantine physician or inspector, who shall, if he deems it expedient, forward orders through quarantine boat or other means, taking care that there is no intercourse between the ship or boats belonging to the vessel and the parties furnishing the supplies. Should any direct personal intercourse be had between any persons from such vessel and provision boat as provided for in this section, each and every such person so offending shall be fined not exceeding $100.

SEC. 15. It shall be the duty of the quarantine physician to visit every vessel coming from any port entering the bay of Apalachicola. He shall require the master or owner of every vessel thus inspected to pay for the use of the board of health as follows: Vessels of ten tons and under, $2; vessels over ten and under twenty tons, $3; vessels over twenty tons, $5.

Except, however, that vessels under ten tons coming from Saint Joseph Bay on the west and Saint Teresa on the east shall be exempted from such charges; provided such excepted vessels have had no communication with any other boat or vessel from an infectious port.

SEC. 16. Each and every vessel fumigated shall pay for such fumigation at the rate of five cents per ton, American measurement, and shall also pay the cost of the disinfectants used, as well as the cost of boat-hire to reach such vessel, which fee, together with all other quarantine dues, shall be collected in United States currency, or by order on consignee, by the quarantine physician, and paid by him to the secretary of the board of health, to be set aside as quarantine funds, and paid out only on order of the board of health, and in all

cases the quarantine officer shall collect the bill of charges made against such vessel before giving permission to leave quarantine.

SEC. 17. The quarantine physician shall make a weekly report to the secretary of the board of health, showing the number and class of vessels visited by him and amount of fees and charges collected, and shall pay all fees and charges to the board of health.

SEC. 18. That every pilot boat on the bars of Apalachicola and masters of tugs and lighters shall be supplied with copies of these regulations, and it shall be the duty of every pilot to furnish a copy of this proclamation to the master of every vessel which said pilot may speak or board immediately upon said communication, and any pilot failing or refusing to do so shall be fined in a sum not exceeding one hundred dollars.

SEC. 19. Any violation of any of these rules or regulations of quarantine shall be punished in the manner prescribed by act regulating quarantine, passed by the legislature and approved March 11, 1879, which provides, in sections 16 and 13, that any such violations shall be punished by the mayor: and violations may be reported by the secretary or president of the board of health to the mayor, who is hereby required to enforce the same as herein provided for.

SEC. 20. It shall be the duty of all vessels coming from foreign ports, entering the harbor of Apalachicola through East or West Pass, to stop at the quarantine stations as designated for each Pass, and failure or refusal to do so shall be punished by fines as herein provided for.

SEC. 21. It is required of the port physician to place one large yellow flag at both East and West Pass stations and at the mouth of Crooked Channel, and at the mouth of Straight Channel. These two latter points shall be the nearest point to the city which any vessel or boat shall approach to the city of Apalachicola without a permission from the port physician.

SEC. 22. The port physician shall also be a port inspector, and is authorized to appoint one or more special inspectors when he deems it necessary.

SEC. 23. An extra inspector at East Pass shall be appointed, which said inspector shall receive the fee of $5 for all vessels over one hundred tons entering through East Pass as visited by him. Such inspector shall come as near town as the two nearest points designated, and there remain until he reports and confers with the port physician. But such inspector may give a written permit for the master of any such vessels to approach the nearest place designated, and shall not permit any more persons of the crew of said vessel to go with such master than may be absolutely necessary to handle the ship's boat such master may come in.

SEC. 24. The compensation of the port physician and boatman shall be hereafter regulated.

SEC. 25. Any and all fines and penalties shall be paid in United States currency, and any person failing or refusing to pay any fine shall be placed in jail until such fine and costs are paid.

Whereas the Apalachicola board of health recognizes a feature in the quarantine system of the United States inaugurated and advised by the National Board of Health and approved and acted upon by Congress, to the effect "that the United States consuls of the different maritime places of the world, whence vessels are bound to ports of the United States, before departure shall perform, or cause to be performed, by a competent medical officer, the duty of inspection, and certify to bills of health, in accordance with the rules and regulations of the National Board of Health"; and

Whereas it is agreed between the National Board and the Apalachicola board of health that "all vessels destined to this port that shall have any infectious or contagious disease on board shall proceed without delay to the refuge station at Ship Island, and there be subjected to special sanitary care": Therefore,

Be it resolved, That the timber and commission merchants, and all others interested, be furnished copies of these rules and regulations, and that the secretary of this board send copies of this proclamation to the National Board of Health.

Adopted June 3, 1882.

P. WISE,
President of Board.
C. E. HOBART,
Secretary.

INSPECTION OF IMMIGRANTS.

The inspection of immigrants was inaugurated on the 1st of June, since which date reports to June 23 have been received from the inspectors at Hornellsville and Rochester, N. Y., Pittsburgh, Pa., Cleveland, Ohio, and Detroit and Port Huron, Mich. The number of immigrants inspected during the period embraced in these reports aggregates 41,777, as follows: At Hornellsville, 7,956; at Rochester, 10,572; Pittsburgh, 3,161; Cleveland, 6,864; Detroit, 7,736; and at Port Huron, 5,479. Of the immigrants inspected, 482 were vaccinated by the inspectors. Two cases of small-pox were removed from the train near Buffalo, N. Y., and transferred to the care of the local health authorities, and the car upon which they were found was immediately fumigated and disinfected.

On May 27 a case of small-pox was discovered at Port Huron, Mich., on a train from Quebec, but the train left the city with the case on board before communication could be had with the health authorities. On the 29th another case was discovered and removed to the hospital. This case was in the eruptive stage, and the patient had left New York City on the 27th.

Aside from the cases above reported, no cases of contagious disease, except that of measles, were discovered on the immigrant trains.

QUARANTINE REPORTS.

SHIP ISLAND STATION.

Dr. T. S. Scales, superintendent, reports the arrival of three vessels during the week ending June 17. The British bark Veritas, which was placed in quarantine June 9, was fumigated and discharged June 12.

NEW ORLEANS QUARANTINE STATION.

Dr. S. E. Chaillé, supervising inspector, transmits the report of Dr. G. F. Patton for the week ending June 16, during which period eleven vessels arrived at the quarantine station. Three of these were from Rio de Janeiro, six from Havana, and two from Vera Cruz. Yellow fever is reported as prevalent at all of these ports.

No cases of contagious or infectious disease were found on board any of the vessels, nor did any develop at quarantine.

By an order of the board of health of New Orleans, on and after June 15 vessels from all infected ports, except Vera Cruz, are directed to be detained at quarantine ten days.

RIVER INSPECTION—NEW ORLEANS.

Dr. Chaillé also transmits the reports of Drs. McCutchan and Parham for the week ending June 18, during which period seven steamboats and three barges were inspected. Number of persons on board, 566. No cases of sickness reported.

MOBILE.

Dr. E. H. Fournier, health officer, transmits reports for the two weeks ending June 25. Three vessels were placed in quarantine during the week ending June 18. The barks Madras and Harry Bailey, from Rio de Janeiro, were fumigated, disinfected, and discharged, the one on the 17th and the other on the 18th. The bark Perseverance, from Carvellas, was detained in quarantine until the 23d, when, after fumigation and disinfection, she was discharged.

REPORTS OF CORRESPONDENTS OF THE NATIONAL BOARD OF HEALTH.

ALLEGHENY, PA.—Dr. J. H. Wright, city physician, reports 2 cases of varioloid, and 1 death from small-pox, during the week ending June 24.

ATLANTA, GA.—Dr. James B. Baird, secretary of the board of health, reports 3 deaths, colored, in small-pox hospital, during the week ending June 17.

BOSTON, MASS.—C. E. Davis, jr., clerk, reports 39 cases of diphtheria, 10 of scarlatina, 3 of typhoid fever, and 1 of small-pox, during the week ending June 24.

BUFFALO, N. Y.—Dr. W. C. Phelps, health physician, reports 2 cases of small-pox during the week ending June 17.

CARROLLTON, MISS.—Dr. G. W. Vasser writes, under date of June 17, that whooping-cough is prevalent.

DETROIT, MICH.—Dr. O. W. Wight, health officer, reports 4 cases of diphtheria, 19 of scarlet fever, and 2 of small-pox, during the week ending June 24.

ERIE, PA.—Dr. Ed. W. Germer, health officer, reports 1 death from small-pox and 3 new cases during the week ending June 24.

HAVANA, CUBA.—Advices received from Havana state that there were 43 deaths from yellow fever in that city during the week ending June 16, at which date it was estimated that there were not less than 200 cases in the city. The American brig Emma sailed from Havana for Philadelphia on June 15, with her captain on board sick with yellow fever. She had discharged cargo in Havana at an infected wharf, and two of her crew had suffered from yellow fever prior to the time when the captain was prostrated with the disease.

LAKE, ILL.—Dr. A. L. Cory reports 3 cases of small-pox during the week ending June 17.

LANSING, MICH.—Dr. H. B. Baker, secretary of the State board of health, reports that during the week ending June 17, neuralgia, diarrhœa, and measles increased, and remittent fever and influenza

decreased in area of prevalence in the State. From June 10 to 22, diphtheria was reported present in 14 places, scarlet fever in 19, measles in 17, and small-pox in 7 places, as follows: Port Huron, 1, an emigrant, now convalescent; Kalamazoo, 2 cases; at Detroit, Flint, and in the Wayne County pest-house, number of cases not stated; at Grand Rapids, 3 deaths during the week ending June 17; and June 21 3 new cases; Battle Creek, June 22, 1 new case.

LOUISVILLE, KY.—Dr. E. R. Montgomery, health officer, reports 5 cases of small pox during the week ending June 24. All of these cases are in hospital. No deaths were reported during the week.

LYNCHBURG, VA.—Dr. Thomas L. Walker, president of the board of health, writes under date of June 24, that small-pox is abating. There are still 8 cases remaining in hospital, all of which are convalescent.

MILWAUKEE, WIS.—Dr. E. W. Diercks reports 8 cases of scarlatina during the week ending June 24. No deaths from contagious or infectious diseases were reported during the week.

NEWARK, N. J.—Dr. F. B. Mandeville writes, under date of June 19, that small-pox has disappeared. This is the first time the city has been entirely free from the disease since November, 1881.

PANAMA, UNITED STATES OF COLOMBIA.—Advices received from Panama, under date of June 10, state that small-pox is abating, there being but a few mild cases remaining. Yellow fever has made its appearance. Eight workmen on the canal have already died in the hospital recently opened, of *fever*, so called, in the hospital report, though the real cause of death was probably yellow fever. A telegram received at Panama on June 9, from a physician in Aspinwall, states that small-pox and yellow fever are prevalent in that city.

PITTSBURGH, PA.—Dr. W. Snively, health officer, reports 5 cases of small-pox and varioloid during the week ending June 17, and 3 cases during the week ending the 24th.

READING, PA.—Dr. E. A. Howell, secretary, reports 8 cases of scarlatina during the week ending June 13, and 15 cases of scarlatina during the week ending June 20.

SAINT JOSEPH, MO.—Dr. F. C. Hoyt reports one case of small-pox during the week ending June 10.

WHIPPLE BARRACKS, ARIZONA TERRITORY.—Dr. J. O. Skinner, assistant surgeon, United States Army, reports to the Surgeon-General, under date of June 17, that two cases of small-pox are now under treatment in the pest-house, located three miles from Prescott, and two miles from the military post.

ABSTRACTS FROM CONSULAR REPORTS.

BELFAST, IRELAND.—A. B. Wood, United States consul, transmits the report of births and deaths in 15 urban sanitary districts in Ireland for the week ending June 3. Total number of deaths in 16 districts, with an aggregate population of 843,553, was 374; giving an average annual death-rate of 23.1 per thousand of population. Among the deaths reported were 8 from measles, 3 from scarlet fever, 1 from small-pox, 7 from typhus fever, 4 from enteric fever, 8 from diarrhœa and dysentery, 52 from phthisis pulmonalis, and 76 from diseases of the respiratory organs. In Belfast the total number of deaths during the week was 98, giving an annual death rate of 24.5 per thousand of population. Of the deaths reported 15 were from phthisis pulmonalis, and 26 from diseases of the respiratory organs. Of the 7 deaths from typhus fever, 2 occurred in Cork, 2 in Waterford, and 3 in Lurgan.

BORDEAUX, FRANCE.—G. W. Roosevelt, United States consul, transmits report for the month of May, during which period 431 deaths are reported against 432 in the preceding month. Population, 215,140. Among the deaths reported were 10 from small-pox, 18 from measles, 3 from scarlatina, 3 from typhus fever, 8 from croup, 2 from whooping-cough, 8 from bronchitis, 26 from pneumonia and pleurisy, and 77 from phthisis pulmonalis.

BREMEN, GERMANY.—John M. Wilson, United States consul, reports total number of deaths during the week ending May 27 at 53, giving an annual death-rate of 24 per thousand of population. Of the deaths reported, 8 were from consumption, 10 from pneumonia, 3 from acute bronchitis, 2 from scarlet fever, and 3 from whooping-cough. Of the total number of deaths 22 were of children under 5 years of age.

BRESLAU, GERMANY.—Henry Dithmar, United States consul, reports a total of 77 deaths from all causes during the week ending May 27, giving an annual death-rate of 33.08 per thousand of population. Of the total number of deaths, 65 were from diseases of the respiratory organs.

CALCUTTA, BRITISH INDIA.—H. Mattson, United States consul-general, reports a total of 269 deaths from all causes during the week ending April 29, giving an annual death-rate of 32.4 per thousand of population, against 25.5 in the previous week. Of the deaths reported, 106 were from cholera, 22 from diarrhœal diseases, 45 from fevers, 14 from tetanus, 10 from phthisis pulmonalis, 6 from bronchitis, and 6 from asthma. The high death rate is attributed to the excessive mortality from cholera, which is confined to the northern section of the city.

CHICLAYO, PERU.—Alfred Lapoint, United States consul, writes, under date of May 12, that yellow fever has disappeared from the district of Lambeyeque.

GENOA, ITALY.—J. F. Hazelton, United States consul, transmits report for the year 1881, during which period a total of 5,123 deaths from all causes were reported. Of this number 6 were from small-pox, 125 from typhoid and typhus fevers, 55 from measles, 124 from scarlatina, 80 from diphtheria, 132 from croup, 26 from whooping-cough, 443 from pneumonia, 551 from bronchitis, 315 from phthisis pulmonalis. Of the total number of deaths, 1,730 were of children under 5 years of age.

HAVANA, CUBA.—R. O. Williams, United States consul, reports a total of 143 deaths from all causes for the week ending June 10. Population, 195,437. Of the deaths reported, 35 were from yellow fever. The city is reported in bad sanitary condition.

LEITH, SCOTLAND.—J. A. Leonard, United States consul, transmits report of mortality in the 8 principal towns in Scotland during the week ending June 3, during which period the total number of deaths reported from all causes was 537, giving an annual average death-rate of 22.9 per thousand of population, ranging from 15.0 in Dundee to 30.4 per thousand in Greenock. Of the deaths reported, 15 were from measles, 7 from scarlet fever, 10 from diphtheria, 18 from whooping-cough, 19 from fevers, 16 from diarrhœal diseases, and 125 from bronchitis, pneumonia, and pleurisy. In Leith the total number of deaths reported during the week was 30, giving an annual death rate of 24.6 per thousand of population, against 26.0 in the corresponding week of 1881.

LISBON, PORTUGAL.—H. W. Diman, United States consul, transmits report for the two weeks ending May 20, during which period 296 deaths were reported. Of this number 24 were from small-pox.

LIVERPOOL, ENGLAND.—W. P. Paul, United States vice-consul, reports 274 deaths during the week ending May 27. Population, 560,377. Of the deaths, 4 were from typhoid fever, 7 from typhus fever, 9 from measles, 6 from scarlatina, 14 from whooping-cough. The following cases were reported during the week: Small-pox 2, typhoid fever 12, typhus fever 27, scarlatina 13, and measles 56.

LONDON, ENGLAND.—L. H. Mitchell, United States deputy consul-general, transmits the report of births and deaths in 28 of the largest English towns during the week ending June 3. The births reported during this period were 4,909, and the deaths from all causes 3,237, giving an average annual death-rate of 19.9 per thousand of population, estimated at 8,459,573. Of the deaths reported, 16 were from small-pox, 139 from measles, 82 from scarlet fever, 20 from diphtheria, 156 from whooping-cough, 45 from fevers, and 42 from diarrhœa. In London the births were 2,176, and the deaths 1,304. Allowing for increase of population, the births were 383, and the deaths 172 below the average numbers in the corresponding week of the last 10 years. The annual death-rate from all causes, which had been equal to 19.0 and 19.2 per thousand in the two preceding weeks, declined last week to 17.5, and was considerably lower than in any previous week of this year. During the past 9 weeks of the current quarter the death-rate averaged 20.1 per 1,000, against 19.4 and 20.7 in the corresponding periods of 1880 and 1881. The 1,304 deaths, included 6 from small-pox, 50 from measles, 37 from scarlet fever, 12 from diphtheria, 91 from whooping-cough, 13 from enteric fever, 2 from ill-defined forms of continued fever, 13 from diarrhœa and dysentery, 1 from simple cholera; thus 225 deaths were referred to these diseases, being 8 below the corrected average number in the corresponding week of the last 10 years. The fatal cases of small-pox, which had been 9 and 10 in the two preceding weeks, declined to 6 last week, and were 21 below the corrected weekly average. The number of small-pox patients in the Metropolitan Asylum hospitals, which had declined in the five preceding weeks from 350 to 266, were 272 at the close of the week ending June 3. The new cases of small-pox admitted to these hospitals during the week were 43 against 59, 49, and 31 in the three previous weeks. The fatal cases of whooping-cough were 91, as against 108 and 123 in the two previous weeks, and was the smallest number recorded in any week since the middle of last December, although still exceeding the corrected weekly average by 22. The deaths from enteric fever numbered 13 during the week and were one above the corrected average. In the Metropolitan Asylum fever hospitals 73 cases of enteric and 10 of typhus

[Continued on page 9.]

REPORT OF MORTALITY IN CITIES OF THE UNITED STATES FOR THE WEEK ENDING JUNE 17, 1882.

States.	Cities.	Total population, according to the United States census of 1880.	Total number of deaths.	Representing an annual death-rate per 1,000 of—	Population, according to United States census of 1880.		Number of deaths.		Annual death-rate per 1,000.		Population under 5 years.		Number of deaths under 5 years.		Annual death-rate per 1,000.		Accidents.		Cerebro-spinal meningitis.		Consumption.		Croup.	
					W.	C.	W.	C.	W.	C.	W.	C.	W.	C.	W.	C.	W.	C.	W.	C.	W.	C.	W.	C.
Me	Portland	33,810	7	10.8	33,480	330	7		11.0				1				1				1			
	Rockland	7,600	1	6.9																				
N. H.	Concord	13,838	2	7.5	13,771	67	2		7.5										1					
Mass	*Boston	397,628	146	19.1	391,039	6,589	144	2	19.3	15.8			56				7				29		3	
	*Cambridge	54,500	8	7.7	52,922	1,578	8		7.8				3				1				2			
	Edgartown	1,301	0		1,238	63																		
	New Bedford	30,000	10	17.4	28,474	1,526	9	1	18.3				1				1				3			
	*Newburyport	13,537	5	19.3	13,469	68	5		19.3				2								2			
	Nantucket	3,726	2	28.0	3,657	69	2		28.4															
	Plymouth	7,094	1	7.1	6,930	154	1		7.5												1			
	*Fall River	50,507	18	18.5	50,300	207	18		18.6				11						1		2			
	Lowell	59,485	24	21.0	59,307	178	24		21.1				8				1		1		1			
	Lawrence	39,178	14	18.6	39,026	152	14		18.7				5						1		3		1	
	Pittsfield	13,367	1	3.9	13,047	320	1		4.0															
	Worcester	58,295	19	16.9	57,528	767	19		17.2				5								5			
	Lynn	38,284	10	13.6	37,730	554	10		13.8				2								4			
	*Brockton	14,563	7	25.1	14,523	40	7		25.1				1								1			
	*Holyoke	25,550	7	14.4	25,500	50	7		14.4				1				1							
	Bridgewater	3,620	0		3,594	26																		
	Milford	9,310	0		9,267	43																		
	*Chicopee	11,416	3	13.8	11,415	1	3		13.8												1			
	*Fitchburg	13,310	3	11.8	13,280	30	3		11.8												1			
	*Somerville	26,359	6	11.9	26,339	20	6		11.9				3				1				1			
	Springfield	33,340	13	20.3	32,592	748	13		20.8				3						1		2			
	*Spencer	7,766	1	6.7	7,756	10	1		6.7															
	Quincy	10,529	2	9.9	10,438	91	2		9.9												1			
	Northampton	12,172	1	4.3	12,044	128	1		4.4															
	North Adams	10,192	4	20.5	10,133	59	4		20.5				1											
	*Haverhill	20,000	7	18.3	19,800	200	7		18.4				2								2			
	Gloucester	19,329	4	11.0	19,309	20	4		11.0				1								1			
	*Chelsea	25,000	6	12.5	24,000	1,000	6		12.6				3								1			
	Clinton	8,030	1	6.5	8,019	11	1		6.5												1			
	Beverly	8,445	2	12.6	8,421	24	2		12.6				1											
	*Malden	13,000	3	12.0	12,940	60	3		12.0															
	Attleboro'	11,111	6	28.2	10,975	136	6		28.3				2				2							
	Salem	27,598	8	15.1	27,396	202	8		15.3				3								4			
	Taunton	21,213	3	7.3	21,102	111	3		7.4												3			
	*Westboro'	5,772	2	18.1	5,736	36	2		18.2															
	Weymouth	10,571	4	19.8	10,521	50	4		19.8				1								1			
	*Waltham	13,000	8	32.1	12,975	25	8		32.1				1								3			
	*Westfield	8,000	0		7,900	100																		
	Brookline	8,053	2	12.9	8,036	17	2		12.9															
	*Woburn	11,453	3	13.6	11,400	53	3		13.6				2								1		1	
	Newton	16,995	7	21.2	16,780	215	7		21.3												1			
	Marblehead	7,467	4	28.0	7,456	11	4		28.0				1								1			
	*Peabody	9,500	2	11.0																				
	*Hyde Park	7,311	2	14.3									1								1			
	*Holliston	3,099	1	16.8	3,092	7	1		16.8															
R. I.	*Providence	111,913	37	17.2	108,022	3,891	36	1	17.4	13.4			6	1			3		2		7			
Conn	*New Haven	70,000	24	17.9	67,600	2,400	24		18.5				11								4			
	*New Britain	15,500	2	6.7	15,420	80	2		6.7				1						1		1			
	*Norwich	22,641	10	23.1	20,579	562	9	1	21.3	81.4			2				1	1			3			
N. Y.	*New York	1,242,533	608	25.5	1,221,491	21,042	596	12	25.4	29.8			265				26		9		87	4	15	
	*Brooklyn	604,356	218	18.7	595,356	9,000	212	6	18.7	34.7			91	1			11				28		2	
	*Yonkers	20,010	6	15.6	19,636	380	6		15.9				2											
	Poughkeepsie	20,207	6	15.5	19,513	694	6		16.1				3								1			
	Newburg	18,050	5	14.5	17,480	570	5		14.9				1								1			
	*Rochester	100,000	50	26.1	99,300	700	50		26.3				11				4				9			
	*Buffalo	175,000	62	18.5	174,000	1,000	62		18.7				32				3		5		6		1	
	Cambridge	1,850	0		1,800	50																		
	Seneca Falls	5,880	1	8.7	5,839	41	1		8.7															
	Tarrytown	3,025	3	47.7	2,959	66	3		48.0				1								1			
	Utica	33,913	17	26.2	33,669	244	16	1	24.8	214.4			2				2				3	1		
	*Syracuse	60,000	20	17.4									8								4			
	Peekskill	6,893	2	14.8	6,684	209	2		15.6				1											
	New Brighton	12,679	6	24.8	12,546	133	6		24.9				2								1			
	Watertown	10,697	7	34.2	10,589	108	7		34.3				2				1							
	Sandy Hill	2,487	0		2,468	19																		
	Luzerne	1,438	1	36.2	1,435	3	1		36.2															
	Ogdensburg	10,341	2	10.1	10,328	13	2		10.1												1			
	Southold	5,417	2	19.2																				
	Herkimer	3,593	0		3,668	15																		
	Oswego	21,116	9	22.2	20,983	133	9		22.3				3								2		1	
	*Auburn	25,000	10	20.8	24,500	500	10		21.3				1				2				3		1	
	*Newtown	10,000	3	15.7	9,800	200	2	1	10.6	258.2								1						
	Cornwall	3,833	0		3,725	108																		
	Greenburg	8,934	6	34.3									3						1		1			
	Cohoes	20,541	4	10.2									1				1							
	Rome	12,045	1	4.3																				
	Fort Edward	5,000	2	22.2									1				1							
	Kingsbury	2,127	1	24.5																				
	Binghamton	17,315	5	14.1									1								1		1	
	*West Troy	12,100	6	25.7									2								3			
N. J.	*Hudson Co.	198,600	91	24.3	196,600	2,000							41				2		3		8		1	
	*Newark	140,000	66	26.1	136,000	4,000	64	2	24.5	26.0			29				1		5		10			
	Camden	41,658	14	17.5	38,064	3,594	13	1	17.8	14.4			4	1							2			
	Plainfield	8,126	4	26.1	7,633	493	4		27.3												1			
	*Atlantic City	6,000	3	26.1	5,200	800	2	1	20.0	65.2			3								2			
Pa	*Philadelphia	886,549	333	19.6	851,339	35,000	305	28	21.5	41.4			108				8		1		38		7	
	*Pittsburgh	170,000	68	20.8	165,000	5,000	65	3	20.5	32.2			34	3			1	1			5			
	*Erie	30,000	9	15.7	29,700	300	9		15.8				2				1				2			
	Reading	43,280	17	20.5	42,926	354	17		20.6				6				1							
	*Meadville	8,955	3	17.5	8,695	260	3		18.0				3											
	*Carlisle	6,209	3	25.2			2	1														1		
Del	*Wilmington	46,500	19	21.3	40,500	6,000	15	4	19.2	34.8			6	1			1				4			
	Milford	2,274	0		1,738	536																		

* Estimated population.

REPORT OF MORTALITY IN CITIES OF THE UNITED STATES FOR THE WEEK ENDING JUNE 17, 1882.

Diarrhoeal diseases.		Diphtheria.		Erysipelas.		FEVER. Typhoid.		FEVER. Malarial.		FEVER. Scarlet.		ACUTE LUNG DISEASES. Pneumonia.		ACUTE LUNG DISEASES. Congestion of lungs.		ACUTE LUNG DISEASES. Bronchitis, acute.		ACUTE LUNG DISEASES. Pleurisy.		Measles.		Puerperal diseases.		Small-pox.		Whooping-cough.		Other diseases.		Cities.	States.
W.	C.	W.	C.	W.	C.	W.	C.	W.	C.	W.	C.	W.	C.	W.	C.	W.	C.	W.	C.	W.	C.	W.	C.	W.	C.	W.	C.	W.	C.		
												1																4		Portland	Me.
												1																		Rockland	
																												1		Concord	N. H.
4		6	1			2				3		14				7		1		2		1						65	1	Boston	Mass.
																1												4		Cambridge	
																														Edgartown	
1																										1		3	1	New Bedford	
																												3		Newburyport	
																												2		Nantucket	
																														Plymouth	
										1						2												12		Fall River	
1		1				1						2				1												15		Lowell	
1												2		1														5		Lawrence	
																1														Pittsfield	
2												1		1														10		Worcester	
												2																4		Lynn	
		2																										4		Brockton	
1						1																1						7		Holyoke	
																														Bridgewater	
																														Milford	
								1																				1		Chicopee	
																												2		Fitchburg	
																1												3		Somerville	
						1						1																8		Springfield	
																												1		Spencer	
																												1		Quincy	
																												1		Northampton	
1						1																						2		North Adams	
																												5		Haverhill	
																												3		Gloucester	
						1								1														3		Chelsea	
																														Clinton	
																												2		Beverly	
																												3		Malden	
1						1																						2		Attleboro'	
																1												3		Salem	
																														Taunton	
		1																										1		Westboro'	
												1																2		Weymouth	
1												1																3		Waltham	
																														Westfield	
																												2		Brookline	
																												1		Woburn	
																												6		Newton	
												1				1												1		Marblehead	
																1												1		Peabody	
																												1		Hyde Park	
																												1		Holliston	
1				1		1						5				1	1									1		14		Providence	R. I.
										1						1				1								17		New Haven	Conn.
																														New Britain	
												1																4		Norwich	
22	1	24		2	1	2		9		31		55				30				21		11		6		12	1	234	5	New York	N. Y.
7		4						6		17		21	1	5		6				4		4				6		91	5	Brooklyn	
										1																		5		Yonkers	
		1						1																				3		Poughkeepsie	
		1												1														2		Newburg	
1		2						1		2		3		3		1												24		Rochester	
4						1		2		1		3				1				6								29		Buffalo	
																														Cambridge	
																										1				Seneca Falls	
																												2		Tarrytown	
												3				1												7		Utica	
2		1										1																12		Syracuse	
1																												1		Peekskill	
1														1														3		New Brighton	
		1								1				1														3		Watertown	
																														Sandy Hill	
																						1								Luzerne	
																												1		Ogdensburg	
																												2		Southold	
																														Herkimer	
		1																										5		Oswego	
		1																		2								1		Auburn	
																												2		Newtown	
																														Cornwall	
		1																										3		Greenburg	
														1														2		Cohoes	
																												1		Rome	
										1																				Fort Edward	
																												1		Kingsbury	
																												3		Binghamton	
										1		1																1		West Troy	
2		4		2		2				8		10				5				3		6		1				34		Hudson Co.	N. J.
4		5								5		4				1				1		2						26	2	Newark	
		1				1				2				1														6	1	Camden	
						1						2																		Plainfield	
																													1	Atlantic City	
7		17		3		9				11		35		3						1		1		4				160	28	Philadelphia	Pa.
2		6								1		8		2		2	1			3	1			1		2		32		Pittsburgh	
		1																										5		Erie	
										3																		13		Reading	
1																												2		Meadville	
1																						1								Carlisle	
1										1		1																7	4	Wilmington	Del.
																														Milford	

REPORT OF MORTALITY IN CITIES OF THE UNITED STATES FOR THE WEEK ENDING JUNE 17, 1882—**Continued.**

States.	Cities.	Total population, according to the United States census of 1880.	Total number of deaths.	Representing an annual death-rate per 1,000 of—	Population, according to United States census of 1880.		Number of deaths.		Annual death-rate per 1,000.		Population under 5 years.		Number of deaths under 5 years.		Annual death-rate per 1,000.		Accidents.		Cerebro-spinal meningitis.		Consumption.		Croup.	
					W.	C.	W.	C.	W.	C.	W.	C.	W.	C.	W.	C.	W.	C.	W.	C.	W.	C.	W.	C.
D.C.	*Dist. of Col	186,295	77	21.5	123,112	63,183	35	42	14.8	34.6			19	23			2	4			5	13		
Va.	*Richmond	66,000	49	38.7	38,800	27,200	21	28	28.1	53.8			11	18						1	2	1		
	*Lynchburg	20,240	14	36.0	8,527	11,713	5	9	30.6	40.1				8							2	1		
W.Va.	Wheeling	31,266	22	35.9	30,551	715	20	2	34.0	145.8			7								2			
N.C.	Wilmington	17,361	4	12.0	6,893	10,468	2	2	15.1	9.9				1										
S.C.	Charleston	49,999	32	33.3	22,712	27,287	5	27	11.7	51.3			2	14			1	1				2		
Ga.	*Augusta	25,000	6	12.5	14,500	10,500	5	1	18.0	5.0			3	1							1			
	Atlanta	37,421	18	24.8	21,086	16,335	5	13	12.2	41.3			3	4								1		
	*Savannah	37,333	21	27.4	20,514	16,819	8	13	20.3	40.3									1		1	3		
	Rome	3,877	4	53.6	2,154	1,723	2	2	49.0	60.4			2	1										
	Brunswick	2,891	2	36.0	1,445	1,446	2		73.8				1											
	Macon	17,000	7	21.5	9,000	8,000	2	5	13.0	27.3											1			
Fla.	Jacksonville	8,000	7	45.7	5,000	3,000	1	6	10.4	103.2			1	1			1	1				3		
	Pensacola	7,227	1	7.2													1							
	Cedar Keys	1,500	0		700	800																		
Ala.	Mobile	31,205	15	25.1	16,837	14,368	9	6	27.7	21.8				2			1				1			
	Selma	7,529	2	13.9	3,345	4,184		2		25.6														
Miss.	*Columbus	5,609	-3	27.9	2,990	2,619	2	1	34.8	19.9				1										
	*Natchez	9,058	6	34.6	5,421	3,637	3	3	28.8	43.2			2	3										
	Vicksburg	11,814	11	48.6	3,975	5,839	6	5	53.8	45.0			2	1								1		
	Shannon	232	0																					
	Verona	974	1	53.5	596	378		1						1										
La.	New Orleans	216,140	126	30.3	158,379	57,761	69	57	22.7	51.3			24	21			4				9	6		
	Baton Rouge	7,217	5	36.3	2,917	4,300	1	4	17.9	49.3			1	1								1		
Tex.	Galveston	22,253	19	44.7	16,900	5,353	14	5	42.4	48.3			6	4						1	1			
	Austin	10,960	3	14.3	7,349	3,611	1	2	7.1	29.2				1										
	*Waco	8,000	2	13.0	5,000	3,000	2		20.9															
	San Antonio	20,561	2	5.1	17,525	3,036	2		6.0								1							
	Dallas	10,358	3	15.1	8,421	1.937	1	2	6.2	54.6			1									1		
	Houston	16,513	9	28.4	10,026	6,487	3	6	15.6	48.2			3					1						
Tenn.	Nashville	43,461	29	34.8	27,004	16,457	16	13	30.9	41.7			9	7							1		1	
	Memphis	33,593	17	26.4	18,622	14,971	6	11	16.7	38.3			4	2								2		
	Trenton	1,383	2	74.5	828	555	1	1	63.0	93.8				1										
	Murfreesboro'	3,800	6	81.6	1,777	2,023	2	4	59.6	99.2			1									3		
	Knoxville	16,000	9	29.9	10,000	6,000	2	7	21.0	81.9			2	4								3		
	*Chattanooga	16,000	8	26.2	10,667	5,333	5	3	24.5	29.3			4	1										
Ky.	*Louisville	123,645	59	21.9	102,842	20,920	36	23	16.1	50.8			15	11					1		5	2		
Ohio	Cincinnati	255,708	137	27.9	247,538	8,170	131	6	27.6	38.9			65	1			3				10	1	1	1
	Gallipolis	4,400	3	35.4	3,474	926	1	2	14.8	112.6							1					2		
	*Dayton	40,000	9	11.7	39,007	993	9		12.0				4								1			
	Portsmouth	11,314	2	9.2	10,346	968	2		10.4				1											
	*Cleveland	185,851	62	17.4	183,651	2,200											3				6		2	
	*Massillon	8,000	1	6.5	7,700	300	1		6.8								1							
Ind.	*Indianapolis	100,000	30	15.7	93,000	7,000	26	4	14.6	29.8			4				11				5	1		
	*Richmond	13,500	2	7.7	12,863	637	2		8.1				2						1					
	Evansville	40,000	9	11.7	37,000	3,000	8	1	11.3	17.2			4				1		1					
	*La Porte	8,000	1	6.5	7,900	100	1		6.6				1											
	*Terre Haute	27,500	8	15.1	26,650	850	8		15.6				4				2				1			
	*Crawfordsville	5,700	1	9.2																				
	*Michigan City	8,004	2	13.0	7,926	78	2		13.1								1							
	Muncie	5,219	1	9.9																				
	*Vincennes	10,000	0																					
Ill.	Chicago	503,304	247	25.7	496,620	6,684							129				7		1		21		1	
	*Peoria	35,000	3	4.4	34,400	600	3														1			
	*Aurora	13,200	2	7.9	11,612	213	2		8.0				1											
	*Elgin	10,005	3	15.7	9,860	145	3		15.8															
	*Moline	9,467	4	22.8	9,370	97	4		22.9				1				1				2			
	*Rock Island	12,460	1	4.2	12,260	200	1		4.3				1											
	Lake	18,396	10	28.3	18,385	11	10		28.3				8				2							
	Quincy	27,268	14	26.7	25,760	1,508	13	1	26.3	34.6			1						1		1			
Wis.	*Milwaukee	125,000	49	20.4	124,500	500							26				2				7		2	
	*Beloit	5,100	3	30.6	5,000	100	3		31.2				2								1		1	
	Fond du Lac	15,000	2	7.0	14,800	200	2		7.1				1				1							
Minn.	Saint Paul	41,498	12	15.0	41,000	498	12		15.3								2							
	Minneapolis	46,887	25	27.8	46,509	378	25		28.0				11								2		3	
Mich.	East Saginaw	19,016	5	13.7	18,832	184	5		13.8				1								1			
	Flint	8,410	1	6.2	8,163	247	1		6.4															
	*Lansing	9,309	2	11.2	8,934	375	2		11.6				1											
	Battle Creek	7,063	2	14.8	6,793	270	2		15.4												1			
	Bay City	20,693	5	12.6									4						1					
	*Detroit	120,000	47	20.4			46	1					15				4		1		4		2	
	*Grand Rapids	35,000	13	19.2									5				1		3					
	*Saginaw	12,000	0																					
Iowa	Dubuque	22,254	1	2.4	22,106	148	1		2.5															
	*Keokuk	15,000	2	7.0	13,700	1,300	2		7.6				1						1					
	*Davenport	23,571	12	26.5	23,341	230	12		26.6				1				2				1			
Mo.	Saint Louis	350,522	172	25.6	328,232	22,290	151	21	24.0	50.0			79	8			9		1		8	1	3	
Nebr.	*Omaha	35,000	13	19.2	34,000	1,000	13		19.9				5				1		1		2			
Kans.	*Lawrence	10,000	1	5.2	8,000	2,000		1		26.1												1		
Colo.	Boulder	3,069	0		3,024	45																		
Utah	*Salt Lake City	22,000	5	11.9	21,800	200	5		12.0				3											
Cal.	San Francisco	233,956	93	20.7	210,515	23,441	82	11	20.3	24.9			29				2	1	1		11	5		
	Vallejo	6,587	2	15.8	6,303	284	2		16.5				2								1			
	*Los Angeles	16,000	6	19.6	14,900	1,100	6		21.0				2								2			
		9,242,705	3,782	21.2									1,347	148			153	11	47	2	439	60	50	1

* Estimated population.

COMPARATIVE STATEMENT OF MORTALITY.

Week ending—	Population.	Total deaths.	Annual death-rate per 1,000.	Deaths under 5 years.
June 19, 1880	8,284,692	3,518	22.2	1,784
June 18, 1881	7,802,584	3,459	23.2	1,387

***REPORT OF MORTALITY IN CITIES OF THE UNITED STATES FOR THE WEEK ENDING JUNE* 17, 1882—Continued.**

Diarrhoeal diseases. W.	Diarrhoeal diseases. C.	Diphtheria. W.	Diphtheria. C.	Erysipelas. W.	Erysipelas. C.	Fever. Typhoid. W.	Fever. Typhoid. C.	Fever. Malarial. W.	Fever. Malarial. C.	Fever. Scarlet. W.	Fever. Scarlet. C.	Acute lung diseases. Pneumonia. W.	Acute lung diseases. Pneumonia. C.	Acute lung diseases. Congestion of lungs. W.	Acute lung diseases. Congestion of lungs. C.	Acute lung diseases. Bronchitis, acute. W.	Acute lung diseases. Bronchitis, acute. C.	Acute lung diseases. Pleurisy. W.	Acute lung diseases. Pleurisy. C.	Measles. W.	Measles. C.	Puerperal diseases. W.	Puerperal diseases. C.	Small-pox. W.	Small-pox. C.	Whooping-cough. W.	Whooping-cough. C.	Other diseases. W.	Other diseases. C.	Cities.	States.
6	5	1							1	1		3			1	1												16	1	Dist. of Columbia	D. C.
6	9			1						1			1															11	18	Richmond	Va.
1						1																			1			1	6	Lynchburg	
		1				4						4				1										1		7	72	Wheeling	W. Va.
								1														1						1	1	Wilmington	N. C.
	3											1	1		2		1										3	3	14	Charleston	S. C.
2	1																											2		Augusta	Ga.
3	3						1																		3			2	5	Atlanta	
			1					2					1															4	8	Savannah	
							1															2							1	Rome	
																										1		1		Brunswick	
	1																											1	4	Macon	
									1																				1	Jacksonville	Fla.
																														Pensacola	
																														Cedar Keys	
1						1	1																					5	5	Mobile	Ala.
																													2	Selma	
								1								1													1	Columbus	Miss.
																												3	3	Natchez	
1	1					1		1		1												1						1	3	Vicksburg	
																														Shannon	
																											1			Verona	
7	5	1				3	1	5	7			2	2							1				3	12			34	24	New Orleans	La.
							1																					1	2	Baton Rouge	
5							1					1				1						1						5	3	Galveston	Tex.
																												1	2	Austin	
1																												1		Waco	
																												1		San Antonio	
																												1	1	Dallas	
2									2																		1	1	2	Houston	
2	6									2		1	1														1	9	5	Nashville	Tenn.
2	2					1		1																				2	7	Memphis	
1									1																					Trenton	
																										1		1	1	Murfreesboro'	
										1			1															1	3	Knoxville	
1						1						1													3	1		1		Chattanooga	
4									1			1	2			2					1			1	2		1	22	14	Louisville	Ky.
3		2				2				9		7	1	1		3				2		6		36	1	1		45	2	Cincinnati	Ohio.
																														Gallipolis	
1												1		1														5		Dayton	
																												2		Portsmouth	
2						1		1		4		4				1				2				1				35		Cleveland	
																														Massillon	
1												2	1											2				5	2	Indianapolis	Ind.
																												1		Richmond	
1	1											1																4		Evansville	
										1																				La Porte	
1								1																				3		Terre Haute	
																												1		Crawfordsville	
																1														Michigan City	
																												1		Muncie	
																														Vincennes	
5		13		1		3		2		6		12				10				6		5		16		5		133		Chicago	Ill.
																												2		Peoria	
														1														1		Aurora	
																												3		Elgin	
																												1		Moline	
																												1		Rock Island	
2										1		1		1						1				1				1		Lake	
1										3																		7	1	Quincy	
1		5				1				1		4				3				2		1						20		Milwaukee	Wis.
																												1		Beloit	
												1																		Fond du Lac	
1		2								1						1										1		4		Saint Paul	Minn.
1		2				3						1								2		4						7		Minneapolis	
		1																										3		East Saginaw	Mich.
												1																		Flint	
																												2		Lansing	
																						1								Battle Creek	
										1																		3		Bay City	
								3		3		5				1				1				1				21	1	Detroit	
		2																						3				4		Grand Rapids	
																														Saginaw	
																												1		Dubuque	Iowa.
																												1		Keokuk	
1												1		1		1												5		Davenport	
20	3	2			1	1		3		8		4	1							2	1		1			1		89	13	Saint Louis	Mo.
2												2		1														4		Omaha	Nebr.
																														Lawrence	Kans.
																														Boulder	Colo.
1						1						1																2		Salt Lake City	Utah.
7	1	1								4		4	1	1		3						1		1				46	3	San Francisco	Cal.
																1														Vallejo	
2																1												1		Los Angeles	
168	42	114	2	10	2	49	6	41	13	139	....	246	14	28	3	97	3	1	....	63	3	51	1	77	22	35	8	1,556	225		

MORTALITY IN FOREIGN CITIES, COMPILED FROM WEEKLY CONSULAR REPORTS TO NATIONAL BOARD OF HEALTH.

Countries.	Places.	Population.	Week ending—	Total deaths.	Annual rate per 1,000.	Cholera.		Yellow fever.		Small-pox.		Typhoid fever.		Typhus fever.		Other contagious diseases.		Weekly mean of thermometer.
						Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	
			1882.															°
Vancouver's Island.	Victoria	6,500	June 10	3	24.0													68.1
Canada	Toronto	86,600	June 24	28	30.1												5	
Do.	Kingston	14,121	June 23	1	3.5													79.6
Bermuda	Hamilton	13,948	June 19	0														79.0
Cuba	Havana	195,437	June 10	143	38.2				35									85.0
St. Christopher	Basseterre	10,000	May 2	6	31.3													87.0
Do.	do	10,000	May 9	10	52.2													83.2
Do.	do	10,000	May 16	5	26.1													83.9
Do.	do	10,000	May 23	5	26.1													83.7
Do	do	10,000	May 30	10	52.2													83.7
Hayti	Port-au-Prince	30,000	May 9	12	20.9													87.0
Do.	do	30,000	May 16	19	33.1					4								88.0
Do	do	30,000	May 23	14	24.4													88.0
Guadaloupe	Pointe-a-Pitre	18,000	May 20	8	23.2													
Do.	do	18,000	May 27	12	34.8													
Trinidad	Spain	30,000	June 6	23	40.0													
U. S. of Colombia	Colon, Aspinwall	3,500	June 17	11	163.9													82.0
Mexico	Mexico	250,000	May 28	305	72.8						5		11					66.2
Do.	Acapulco	4,100	May 14	2	25.4													86.0
Do.	do	4,100	May 21	5	63.5													86.0
Do.	do	4,100	May 28	4	50.8													67.0
Peru	Callao	35,000	June 7	7	10.4													
Brazil	Rio de Janeiro	330,000	May 20	191	30.2				1		4		1		3		4	
Do.	do	330,000	May 27	182	28.8				1		4		3				3	
Venezuela	La Guayra	8,000	June 3	3	19.6													
Do.	do	8,000	June 10	7	45.7													
Ireland	Dublin	348,293	June 10	165	24.6								1		3			54.9
Do.	Belfast	207,671	June 10	79	19.8						3				3			48.7
Do.	Cork	78,361	June 10	48	31.9										2			50.6
Do.	Limerick	38,600	June 10	12	16.2										1			
Do.	Londonderry	28,947	June 10	12	21.6												3	54.7
Do.	Waterford	22,401	June 10	14	32.5										3			56.5
Do.	Newry	14,782	June 10	8	28.1										1			54.1
Do.	Galway	14,621	June 10	4	14.2													
Do.	Drogheda	12,297	June 10	5	21.1													
Do.	Kilkenny	12,299	June 10	6	25.4													
Do.	Wexford	12,163	June 10	4	17.1													
Do.	Dundalk	11,913	June 10	2	8.7													
Do.	Sligo	10,764	June 10	2	9.7													52.7
Do.	Clonmel	10,519	June 10	3	14.8													
Do.	Lurgan	10,184	June 10	4	20.4													54.1
Do.	Queenstown	9,738	June 10	5	26.7										1			50.6
Scotland	Glasgow	514,048	June 10	239	24.2												18	55.6
Do.	Edinburgh	232,440	June 10	94	21.0												12	53.8
Do.	Dundee	145,433	June 10	51	18.2												3	56.7
Do.	Aberdeen	107,378	June 10	48	23.2												4	54.7
Do.	Greenock	70,128	June 10	40	29.7												3	55.4
Do.	Paisley	56,641	June 10	28	25.7												4	55.8
Do.	Leith	63,312	June 10	30	24.6												3	
Do.	Perth	30,206	June 10	13	22.4													
England	London	3,893,272	June 3	1,304	17.5						6		13				190	58.5
Do	Brighton	109,505	June 3	39	18.6												6	57.7
Do.	Portsmouth	129,916	June 3	45	18.1												5	
Do.	Norwich	88,821	June 3	36	21.2												2	
Do.	Plymouth	74,449	June 3	36	25.2												3	56.5
Do.	Bristol	210,134	June 3	86	21.4												13	54.3
Do.	Wolverhampton	76,756	June 3	36	24.5												2	53.7
Do.	Birmingham	408,532	June 3	150	19.2						1						13	
Do.	Leicester	126,275	June 3	44	18.2												4	54.8
Do.	Nottingham	193,573	June 3	77	20.8						2						8	56.5
Do.	Derby	83,587	June 3	39	24.3												3	
Do.	Birkenhead	86,582	June 3	24	14.5												2	
Do.	Liverpool	560,377	June 3	250	23.3												31	54.9
Do.	Bolton	106,767	June 3	53	25.9						1						15	53.1
Do.	Manchester	340,211	June 3	159	24.4						1						13	
Do.	Salford	184,004	June 3	92	26.1												21	
Do.	Oldham	115,572	June 3	69	31.2												9	
Do.	Blackburn	106,460	June 3	41	20.1												1	
Do.	Preston	97,656	June 3	47	25.1												8	
Do.	Huddersfield	83,418	June 3	31	19.4													
Do.	Halifax	74,713	June 3	32	22.3												3	
Do.	Bradford	200,158	June 3	87	22.7												16	
Do.	Leeds	315,988	June 3	134	22.1						2						4	55.0
Do.	Sheffield	290,516	June 3	125	22.4						1						5	53.6
Do.	Hull	158,814	June 3	71	23.3												12	
Do.	Sunderland	119,065	June 3	34	14.9												3	56.8
Do.	Newcastle	147,626	June 3	70	24.7						2						5	
Do.	Cardiff	86,724	June 3	26	15.6													
Do.	Tunstall	29,673	June 3	6	10.5												2	50.7
France	Paris	2,239,928	June 10	1,105	25.7						11		36				103	
Do.	Rheims	92,744	June 11	47	25.9						1		2				1	
Do.	Rouen	104,209	June 10	50	25.0													
Do.	Havre	105,000	June 3	71	35.6													60.8
Do.	Nancy	73,225	June 3	29	20.6								1					
Switzerland	Geneva	69,401	June 3	27	20.3												1	
Do.	Zurich	79,004	June 3	34	22.4								1				1	
Do.	Basel	64,019	June 3	27	22.0								2				4	
Do.	Berne	45,367	June 3	22	25.3													
Do.	Lausanne	30,758	June 3	16	27.1												1	
Do.	Chaux-de-fond	22,856	June 3	10	22.8													
Do.	St. Galle	22,191	June 3	14	32.9												1	
Do.	Luzern	18,377	June 3	10	28.4												2	
Do.	Neuchatel	15,974	June 3	9	29.4													
Do.	Winterthur	14,257	June 3	6	22.0												1	
Do.	Schaffhausen	12,031	June 3	10	43.4												1	
Do.	Biel	12,178	June 3	4	17.1													
Do.	Fribourg	11,647	June 3	11	49.3													
Do	Herisau	11,296	June 3	4	18.5								2					
Do.	Locle	10,487	June 3	6	29.8													
Netherlands	Amsterdam	337,000	June 3	175	27.0								1				11	64

MORTALITY IN FOREIGN CITIES, &c.—Continued.

Countries.	Places.	Population.	Week ending—	Total deaths.	Annual rate per 1,000.	Cholera.		Yellow fever.		Small-pox.		Typhoid fever.		Typhus fever.		Other contagious diseases.		Weekly mean of thermometer.
						Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	
			1882.															°
Netherlands	Rotterdam	157, 270	June 10	80	27.3					4		2				3		
Do	Flushing	11, 000	June 3	3	15.4													
Germany	Bremen	115, 000	June 3	47	21.3												5	
Do	Brunswick	75, 000	June 3	48	33.4												3	61.5
Do	Cologne	146, 767	June 3	88	31.3												2	
Do	Frankfort	137, 000	May 27	62	24.1												6	64.3
Do	do	137, 000	June 3	61	23.7												7	75.1
Do	Mannheim	53, 500	June 10	20	19.5													61.5
Do	Berlin	1, 156, 382	May 20	505	22.7							8		1		130	33	46.4
Wurtemberg	Stuttgart	117, 303	June 3	39	17.4													61.9
Bavaria	Munich	236, 000	June 3	161	36.1						1						21	
Saxony	Leipsic	155, 956	June 3	63	21.0								1				1	62.1
Belgium	Brussels	407, 034	June 3	167	21.3						7		2				7	
Do	Antwerp	185, 480	June 3	75	21.0								1				7	
Do	Ghent	133, 755	June 3	71	27.6						1		2				1	
Denmark	Copenhagen	250, 000	May 30	128	26.6					1		6				14	1	59.7
Italy	Leghorn	99, 211	May 6	29	13.4													66.7
Do	do	99, 211	May 13	45	23.9													68.0
Do	do	99, 211	May 20	27	14.3													62.2
Do	do	99, 211	May 27	33	17.5													79.3
Do	do	90, 211	June 3	31	16.5													81.4
Do	Turin	250, 393	May 13	125	25.5								4				32	64.9
Do	do	250, 393	May 20	129	24.9								10				35	57.1
Do	Genoa	185, 000	June 10	106	29.9													69.8
Austria	Vienna	740, 622	June 3	496	34.8						33		2				17	
Do	Trieste	144, 494	Apr. 30	91	32.9												6	
Do	do	144, 494	May 7	76	27.4								2				6	
Russia	St. Petersburg	927, 647	June 3	662	37.1						17		49				70	
Russian Poland	Warsaw	383, 973	May 27	267	36.6						46							66.2
Norway	Christiania	122, 000	May 27	46	19.6					1	1	4				14	4	56.1
Sweden	Stockholm	174, 706	May 27	74	22.0												2	58.7
Portugal	Lisbon	187, 404	May 13	161	44.8						13							62.3
Do	do	187, 404	May 20	135	37.5						11							61.7
Spain	Malaga	115, 882	May 21	95	42.8								4				8	
Do	Seville	138, 000	May 21	113	42.7						6		4				54	
Do	do	138, 000	May 28	101	38.2						5		2				44	
Egypt	Alexandria	220, 000	June 3	159	37.7													
India	Calcutta	433, 219	May 6	314	37.8		104						5				1	84.5
Do	Bombay	773, 196	May 9	419	26.6		1										230	
Do	do	773, 196	May 16	379	23.5												154	
Japan	Kobe	20, 579	May 20	11	27.8													
Do	do	20, 579	May 27	11	27.8													
Seychelles Islands	Mahé	14, 000	Apr. 22	2	7.4													84.0
Do	do	14, 000	Apr. 29	3	11.2													86.0
Do	do	14, 000	May 6	1	3.7													84.0
Do	do	14, 000	May 13	5	18.6													86.0

[Continued from page 3.]

fever were under treatment at the close of the week. The deaths resulting from diseases of the respiratory organs were 222, as compared with 238 and 242 for the two previous weeks, and were 46 below the corrected average number in the corresponding weeks of the past 10 years. Of the number reported, 113 were from bronchitis and 71 from pneumonia. The deaths from phthisis pulmonalis during the week were 153.

LYONS, FRANCE.—B. F. Peixotto, United States consul, reports a total of 191 deaths during the week ending May 27. Population, 372,887. Of the deaths reported, 2 were from measles, 3 from typhoid fever, and 15 from other contagious or infectious diseases. The eruptive fevers which have for several months been so fatal among children have now ceased to be epidemic.

MATANZAS, CUBA.—David Vickers, United States consul, writes that a few cases of yellow fever and of small-pox were reported during the week ending June 16. No deaths were reported from either of these diseases. Yellow fever is now decreasing, and efforts are being made to restrict the spread of small-pox.

NICE, FRANCE.—G. F. Mosher, United States consul, reports a total of 45 deaths from all causes during the week ending June 3. Population, 49,777. Of the deaths reported, 4 were from bronchitis, 3 from pneumonia, and 13 from acute diseases of the respiratory organs.

PARIS, FRANCE.—George Walker, United States consul-general, reports a total of 1,105 deaths from all causes during the week ending June 7, giving an annual death-rate of 25.65 per thousand of population. Of the deaths reported, 36 were from typhoid fever, 11 from small-pox, 27 from measles, 2 from scarlatina, 4 from whooping-cough, 51 from diphtheria and croup, 196 from phthisis pulmonalis, 27 from bronchitis, 58 from pneumonia, 58 from other diseases of the respiratory organs, and 96 from diseases of the nervous system.

PARAMARIBO, DUTCH GUIANA.—Harry Barnett, United States vice-consul, reports 67 deaths from all causes during the month of April. Population, 23,826. Catarrhal affections are reported as prevalent.

PERNAMBUCO, BRAZIL.—Henry L. Atherton, United States consul, reports a total of 95 deaths from all causes under date of May 13. Population, 120,000. Of the deaths reported, 9 were from small-pox, 1 from typhoid fever, 2 from typhus fever. The number of cases of these diseases is not reported. Small-pox is prevalent in the city, but not in the port; 4 deaths from small-pox were also reported in the city during the week ending May 20.

POINTE À PITRE, GUADELOUPE.—Charles Bartlett, United States consul, reports a total of 20 deaths during the 2 weeks ending May 27. Population, 18,000. Malaria and pernicious fevers are prevalent.

PORT AU PRINCE, HAYTI.—John M. Langston, United States minister resident, reports a total of 45 deaths from all causes during the 3 weeks ending May 23. Population, 30,000. Four cases of small-pox, one of which terminated fatally, were reported during the week ending May 16. Since that time no new cases have been reported.

QUEENSTOWN, IRELAND.—George B. Dawson, United States consul-general, reports a total of 6 deaths from all causes during the week ending June 10. Population, 12,000. Ten cases of typhus fever, one of which terminated fatally, were reported during the week.

SANTIAGO DE CUBA, CUBA.—John C. Landreau, United States consul, reports 84 deaths from all causes during the month of May. Population, 40,000. Of the deaths reported, 7 were from yellow fever, 3 from typhoid fever; 17 cases of yellow fever and 9 of typhoid fever were reported during the month. These cases occurred in the military hospital, the harbor and vicinity being free from all contagious diseases.

ST. PETERSBURG, RUSSIA.—Edward Stanton, United States consul, transmits reports for the 2 weeks ending May 27, during which a total of 1,390 deaths were reported from all causes. Population, 927,467. Of the deaths reported, 24 were from small-pox, 21 from typhus fever, 58 from typhoid fever, and 19 from remittent fever.

SINGAPORE, INDIA.—A. G. Studer, United States consul, writes, under date of May 1, that the city is reported free from diseases of a pestilential character, and reports received from Malacca, 125 miles northwest of Singapore, state that cholera has been quite prevalent

during the last few weeks, though it does not appear to have yet assumed an epidemic character. It is also stated that cholera is again very prevalent at Bangkok, and that many deaths have recently occurred in that place; among them were a few Europeans.

SWATOW, CHINA.—C. C. Williams, United States consular agent, writes that one case of small-pox, 8 of typhoid fever, and 3 of typhus fever were reported in the hospital during the week ending May 13. No report of mortality either in hospital or city at large is attainable, as such records are not preserved by the agents. The city is in bad sanitary condition.

VICTORIA, VANCOUVER'S ISLAND, B. C.—Allen Francis, United States consul, writes, under date of June 3, that 2 cases of small-pox are reported at Seattle, Washington Territory.

VIENNA, AUSTRIA.—J. R. Weaver, United States consul-general, reports a total of 525 deaths from all causes in Vienna and suburbs during the week ending May 27, giving an annual death-rate of 36.9 per thousand of population. Omitting 67 deaths recorded in the suburbs, the annual death-rate in the city proper was equal to 32.2 per thousand of population. Of the deaths reported, 30 were from small-pox, 3 from measles, 18 from scarlet fever, 8 from diphtheria, 7 from whooping-cough, 3 from typhoid fever, 132 from consumption, and 68 from acute lung diseases. The number of births reported during the week was 450.

WINDSOR, ONTARIO.—Charles Ewers, United States consul, reports a total of 3 deaths from all causes during the week ending June 17. Of this number 2 were from small-pox, of which disease 5 new cases developed during the period embraced in the report. There are now 9 cases of small-pox in the pest-house, of which number 6 are convalescent. Three cases of diphtheria and 1 of scarlet fever during the two weeks.

REPORT OF MORTALITY IN CITIES OF THE UNITED STATES FOR THE WEEK ENDING JUNE 17, 1882, *IN WHICH BURIAL PERMITS ARE NOT REQUIRED.*

States.	Cities.	Total population.	Total number of deaths.	Representing an annual death-rate per 1,000.	Number of deaths under 5 years.	Representing an annual death-rate per 1,000 under 5 years.	Accidents.	Cerebro-spinal meningitis.	Consumption.	Croup.	Diarrhœal diseases.	Diphtheria.	Erysipelas.	Fever: Typhoid.	Fever: Malarial.	Fever: Scarlet.	Acute lung diseases: Pneumonia.	Acute lung diseases: Congestion of lungs.	Acute lung diseases: Bronchitis, acute.	Acute lung diseases: Pleurisy.	Measles.	Puerperal diseases.	Small-pox.	Whooping-cough.	Other diseases.
Me	Bath	7,875	1	6.6	1				1																
	Belfast	5,308	3	29.7			1		2																
	Calais	6,162	1	8.5	1																			1	
Vt	Brattleborough	5,880	1	8.0																				1	
Conn	Windham	8,265	0																						
N. J	Bordentown	5,334	1	8.7																					1
	Montclair	5,146	1	10.9					1																
Pa	Allegheny	78,000	25	16.7	10		1		1		1	2		2			1					1			16
	Titusville	9,000	4	23.2	1												1					1			2
Md	Westminster	2,560	2	40.8	1		1				1														
Va	Winchester	5,000	1	10.1																					1
W. Va	Martinsburg	6,534	1	7.9						1															
S. C	Port Royal	387	0																						
	Greenville	6,159	3	25.2				1	1																1
Ga	Milledgeville	3,000	0																						
	Columbus	11,272	6	27.7	4		1				1			1											3
Fla	Tampa	740	1	70.5																					1
Ala	Tuscaloosa	2,000	1	26.1																	1				
Miss	Corinth	2,264	1	23.0																					1
	Crystal Springs	955	0																						
	Decatur	1,000	0																						
	Fayette	400	0																						
	Hernando	1,000	1	52.2																					1
	Inka	816	0																						
	Meridian	4,013	2	26.0	1						1														1
	Pass Christian	4,000	0																						
	Pearlington	1,200	0																						
	Pleasant Hill	253	1	206.2																					1
	New Albany	300	0																						
	Blue Mountain	250	0																						
	Starkville	1,454	0																						
	Senatobia	935	0																						
	McComb	1,970	0																						
	Charleston	350	0																						
Texas	Indianola	900	0																						
	Jefferson	3,251	0																						
	Laredo	5,000	3	39.0	1				1						1									1	
Tenn	Milan	1,800	0																						
Ohio	Bucyrus	4,500	1	11.5																					1
	Circleville	6,400	1	8.1													1								
	Painesville	5,500	2	19.0			2																		
	Youngstown	15,089	4	13.8	3							1			1									1	1
	Pomeroy	6,000	1	8.7										1											
Ind	Madison	8,945	4	23.2			1		2																1
	Rensselaer	912	0																						
Mo	Gun City	125	0																						
	Louisiana	5,000	1	10.2			1																		
Ill	La Salle	10,000	3	15.6			2		1																
Wis	Kenosha	5,500	3	27.9					1																2
	Watertown	9,000	0																						
	Sauk City	1,000	0																						
Minn	Winona	10,000	2	10.4	2					1															1
	Stillwater	9,061	3	17.1	1									1			1								1
Mich	Clinton	1,577	0																						
	Milford	1,400	0																						
Iowa	Muscatine	8,412	1	6.2																					1
	Clinton	10,000	1	5.2								1													
Mont	Helena	3,630	0																						
Cal	Santa Cruz	5,000	1	10.2																		1			
	Totals	337,704	88	13.6			10	1	11	2	4	4		5	2		4				1	3		4	37

NAME	DATE DUE